Determinants of collective action in irrigation water management for canal irrigation schemes managed by local water user associations in Ethiopia: The case of Dura, Laelay Logometi and Dibdebo in Central Tigray

By

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This is to certify that the thesis prepared by Kaleab Emaelaf, entitled: Determinants of collective action in irrigation water management for canal irrigation schemes managed by local water user associations in Ethiopia: The case of Dura, Laelay Logometi and Dibdebo in Central Tigray and submitted in partial fulfilment of the requirements for the degree of Master of Science in Economics (Resource and Environmental Economics complies with the regulations of the university and meets the accepted standards with respect to originality and quality.

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Abstract

Collective action for managing common pool resources is a vital element with many appropriation and provision problems. Challenges of ensuring collective action forces us to identify the determinants of collective action. This study identifies what determines participation of collective action for small scale irrigation farmers using canal irrigation in Central Tigray. It also addresses determinants of intensity of collective action participation given the farmers participate. The study uses Multivariate probit regression to find the determinants of collective action using a cross-sectional data from 240 observation. These observation collected were from Dura, Laelay Logometi and Dibdebo which are kebeles found in the Central Tigray Zone. This survey was conducted in 2016 referring to 2007 E.C. The findings show that determinants of collective action differ according to measurements of collective action; but labour force in the household, income earned from irrigation farming, membership in community organization, age of dam, distance to all weather road and perception of rainfall adequacy affect participation of an irrigation farmer in collective action positively. Heckman sample selection was used to measure intensity of participation in collective action resulting the different determinants to different intensity measurements but age of dam affected intensity of participation positively while size of irrigation dam had different sign with different measurements of intensity. Hence policy makers should take into account the determinants of collective action when designing irrigation projects.

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Acronyms

ATT-Average treatment effect on treated

ETB- Ethiopian Birr

CPRs-Common pool Resources

CSA-Central statistical agency

GDP- Growth domestic product

IWMI- International water management institute

Km- Kilometer

MCE- Metaferia Consulting Engineers

MoFED- Ministry of Finance and Economic Development

MoWR- Ministry of Water resource

OLS- Ordinary least square

PA-Peasant Association

PCI- Principal Component analysis

UNCTAD- United Nations Conference on Trade and Development

VIF- Variance inflation factor

WUA-Water user Association

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Declaration

I hereby declare that this thesis is my own work and has never been presented in any other University. All sources of materials used for this thesis has been properly acknowledged.

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Chapter 1 Introduction

1.1 Background to the Study

Ethiopia, according to the World Bank has a projected population of 99.3 million with a growth rate of 2.5% in 2015, making the country the second most populous country in Africa (World Bank, 2015). The economy has had an agricultural sector which accounted for 50.9% of the GDP, while the service and the industrial sector accounted for 38% and 12.1% respectively around a decade ago but recently the service sector has 46.2% of GDP according to the report by (MoFED, 2013/14) while the agricultural and manufacturing sector consisted 40.2% and 14.3% of GDP, respectively.

Economic growth of Ethiopia is exceptionally affected by the agricultural sector, which rigorously depends on rainfall and also employs 85% of the population. Accelerating this sector will improve agricultural output, increase farmer's income and eliminate the trend of hand to mouth feeding character of agricultural output by the population (Hordofa, et al., 2008).

Ethiopian agriculture still uses rudimentary technology for food crops cultivation. Cereals are the principal staple crops produced in bulk than other crops since they are major food crops. Cereal accounted for 79.34% of the total grain crop production with teff, maize, wheat and sorghum accounting for 22.6%, 17%, 11.89%, 15.92%, respectively (CSA, 2011/2012).

However, the subsistence nature of agricultural production on the major food crops produced being rain fed dependent will not produce the amount of food required by the population hence expansion is inevitable. There needs to be an improvement in production and productivity of food crops (Hordofa, et al., 2008).

Despite the unpredictability of distribution of rainfall, Ethiopia is endowed with bountiful water resource. Which is the main component for irrigation. Irrigation improves utilization of water resource for agricultural productivity and provides options for crop diversification (IWMI, 2007). According to MoFED report Ethiopia has an estimated potential of 5.1 million hectares land available for irrigation. (MoFED, 2010).

Formal irrigation systems were introduced during the imperial regime with the purpose of growing crops for sale like cotton, sugarcane, fruits and vegetables. Irrigation has been exercised for nearly five decades, Modern methods of irrigation were introduced in the 1960s (MCE 2004).

Irrigation is a system that is used to increase harvest since the imperial regime. In Ethiopia, three types of irrigation systems have been practiced which are small, medium and large scale irrigation schemes. Currently small scale irrigation schemes are given priority over medium and large scale, but the previous regimes gave priority to large scale irrigation scheme (Deribe, 2008).

A study conducted in irrigation water management needs solid policy to support small scale irrigation and household water harvesting schemes to bring about job creations for farmers, expansion in productivity of agriculture, improvement in welfare of farmers and increasing availability, intake and access to food. Thus bringing a positive spillover in the other sectors of the economy (Abedin, et al., 2006).

1.2 Statement of the problem

Ethiopia is a country where agricultural production is the backbone of economic growth. Rain-fed agriculture dependency for output demands use of water management technologies. This technologies are complementary to irrigation resulting productivity enhancement. Irrigation complementary water management technologies involve soil conservation practices and planting multiple trees (Ersado, 2005).

Agricultural water management technologies can be simply introduced in an area, but the important thing to notice should be the use of that technology in appropriate ways. These technologies help in maintaining the flow and supply of water for irrigation that would make life easier for the agrarians facing water shortage problem in rain-fed dependent counties like Ethiopia (UNCTAD, 2011).

In allocation of water for irrigation purposes, collective action plays an important role where members set rules for efficient distribution of water from common pool resource i.e. water. The rule set must be in an impeccable balance from the contribution of local participants and the providers or managers of the common pool resource that can be a government or an irrigation association based on the type of irrigation system (Tang, 1991).

Common pool resource are resources accessed based on the geographical placement of each beneficiary. Every user of the resource with an advantage due to placement will gain/benefit greatly from the resource, imposing total loss of use by the other beneficiaries. Collective action is compulsory for proper management in effective use among users and to avoid exploitation (Ostrom & Gardner, 1993).

Common pool resources are usually subject to the problem of unequal distribution due to appropriation and provision decisions. For example in an irrigation scheme appropriation decisions determine the distribution of water among users which is sequential. This scheme therefore reduces accessibility of water as we go along from head enders to tail ender because upstream farmers might free-ride on the water available due to their access to it first. Provision decisions determines the contribution of beneficiaries to the flow of water. Hence based on the appropriation and provision decisions communication among farmers will make it easier to reach an agreement in cooperation that is vital in collective action for water management (Cárdenas, et al., 2009).

Institutional setup was undermined to improve irrigation and agricultural output because much emphasis is given to technological progress. External interventions can hinder the mutual interdependence between farmers, though it is the mode of introduction of technology in irrigation practice’s requiring costs for constant repairs and labor for maintenance. Therefore, conflict might arise even in the improvement of technology for the participants in irrigation systems without the proper institutional format (Ostrom and Gardner, 1993). Institutional involvement in common pool resources will improve collective action by providing funds to finance the running costs for management (Uetake, 2015).

Institutional arrangement has been unnoticed throughout the introduction of irrigation systems In Ethiopia, more focus was given to the advancement in technology than institutional factors and social capital. Social capital performs more adequately than the formal rules and regulation because there is a sense of family and respect among farmers because of social ties (Deribe, 2008).

This study would improve the knowledge gap for the institutional framework in irrigation water management schemes adding the element of transportation cost, as determinant. Inclusion a variable that represent institutions that are informal but also characterize social ties is another addition. Earlier studies considered multiple ways of irrigation (ground water irrigation, pump irrigation, well irrigation etc.) while emphasis should be given to canal irrigation which embodies common pool resource more than other types of irrigation. Collective action should be represented as a combination of different activities that are correlated among one another. Combination of different activities according to local water user association are used to manage canal irrigation. Additional elements that represent farmer's access to information were also taken into consideration. These inputs will help to coin appropriate policy for irrigation schemes, projects and also determinants of intensity of participation for farmers who participate in collective action was considered as an objectives.

1.3 Objective of the study

This study attempts to provide evidence on the determinants of collective action and household's intensity for participating in collective action for irrigation water management in a small scale irrigation schemes in central Tigray

The specific objectives of this study are:

- To identify the determinants of participation in the collective action and intensity of participation in irrigation water management.
- To draw policy implications for improving collective action for irrigation water management

1.4 Significance of the Study

As outlined above in the introduction section, Ethiopia is rainfall dependent agricultural farming based country. This implies that rainfall is seasonal and this rain needs to be properly utilized for enhancing productivity. Because of irrigation water management technologies, this problem seems to have a solution but this technologies demand collective action by farmers. Institutions can boost the know-how in collective action if correctly arranged leading to changes in the efficiency of agricultural production with equitable distribution of water among users. This institutions can also be informal showing social ties among farmers or formal which are extension contacts. Therefore, this study will provide information to policy makers and planners during the design and implementation of irrigation water management projects and programs.

1.5 Scope of the Study

This study is based on a cross-sectional data which was collected in the time period from beginning of August to the end of October 2016 to analyse the determinants of collective action for irrigation water management in small scale irrigation schemes referring to the year 2007 E.C. These small scale irrigation schemes use canal irrigation.

Chapter 2 Literature review

2.1 Common pool resources

Common pool resources are in a mix between perfect public goods and perfect private goods with the characters of difficulty in exclusion from their public good nature and subtractability from their private good nature, according to a definition given by Elinor Ostrom (Ostrom & Gardner, 1993).

Common pool resources are not similar to private goods because of their character of being owned communally making them closer to public goods than private goods. Public goods are goods available in unlimited quantity indicating use of those goods by an individual wouldn't make the stock available to others any less but common pool resources difference from public goods because they are available in a limited quantity (Wade, 1987).

Often, in describing the common pool resources, we use examples to further explain their exact characters. One of the common example can be international fresh water fisheries which exhibit two important characters of partial excludability and rivalry. Partial excludability can be further elaborated as the example given here. Let's consider an international fresh water. If extraction of fisheries is greater than their biological regeneration it is excludable by an authority responsible in managing the international fresh water, the element of partiality comes to those that doesn't have access to the resource due to geological setup. Rivalry among beneficiaries can be explained as one beneficiary extracts the lesser availability to the others (Benvenisti, 1996).

2.2 Institutions and common pool resources

Institutions have existed since ancient times with change in human interaction because they are constructed by the people to affect their behavior indicating they need to be stable and change as the human behavior develops (North, 1990).

Traditional foundations and social norms are difficult to change with the introduction of technology (new ways of doing things) implying changes in the institutional

structure to take a long period of time. Changes within informal institutions being more successful because it encompasses the foundations for a good institutional framework (Williamson, 2000). Informal institutions are usually governed by rules that are unwritten and commonly known by the participants that manage the common pool resource. Acknowledging the importance of informal institutions as formal institutions for management of common pool resources is mandatory (Nemarundwe & Kozanayi, 2003).

Institutional structure differ based upon the specific type of common pool resource. There are two distinction of common pool resources, physical (humanly devised) and biological. Both distinctions differ on their demand for institutional arrangement. Uncertainty in the environment contribute to a higher demand for biological common pool resource. For example fishery is biological CPR which requires appropriation decisions that are complex to manage. Therefore, it demands a carefully well-structured institutions compared to humanly devised common pool resource (Becker & Ostrom, 1995).

(Ostrom, 1990) Classifies understanding between resource units and resource system is vital to manage common pool resources. Resource systems are stock of the resource accessible to be used by beneficiaries. Resource units are what beneficiaries use from the resource system. For example resource system refers to irrigation canal while resource unit refers to the water extracted from the irrigation canal. Appropriation and provision decision are given emphasis because they are structure in managing CPRs. Appropriation can't be simultaneous from resource units but provision can. There can't be joint appropriation because the resource unit available for one beneficiary can't be available for another beneficiary but the resource system can be jointly used.

Provision decision are monitoring, protecting and maintaining continual sustenance of resource systems. Provision and appropriation decisions are different, provision decision are on the resource system while appropriation decision are on the resource unit. This decision lead to the difficulty in managing CPRs. Resource units subtractability creates appropriation problems, this includes free riding, uncertainty and conflict among beneficiaries. These problems cause deterioration of provision

hence beneficiaries must act jointly to eliminate appropriation problems and work towards to strengthen the means of provision (Ostrom, 1990).

Operational rules are rules imposed on property right that are specified for common property. This rules are imposed based on the resource type. According to (Tang, 1991) this rules specify how the resource should be used, who is allowed to use it and what equipment should be used in utilization. Operational rules are constructed by the collective users making it prone to subjective changes by users. It is an informal right not recognized by the government. Optimal management of common pool resources is possible when governed by the combination of formal (governmental recognized) and informal rules, because formal rules have the authority to be enforced by the institution responsible i.e. governmental institution while informal rules are existing rules that has a social foundation and traditional agreement among users. Their cooperation in playing their role in obliging to informal rules in the community and formal rules of the governmental institution makes management of common pool resources better (Schlager & Ostrom, 1992).

According to (Schlager & Ostrom, 1992) right devised by institutions formal or informal depends on 3 factors listed here. 1) Stability of institution when challenged by a shock 2) the cost of enforcing the new rules and 3)condition that affect the introduction of better property right regime according to resource.

Institutions determine the rules of the social interaction game in common pool resources. Different institution setups exist affecting the decision making process in common pool resources. Appropriate institutional setups have to be flexible and move accordingly to the change in society henceforth adding cost element commonly referred as transaction cost. Transaction costs are costs that exist due to lack of information. Transaction cost are positive with an existence of an institution in the short run requiring reduction in the long run. Introduction of contrasts and the existence of law between interacting bodies are possible solutions (Brousseau & Glachant , 2008).

According to (Matthews, 1986) contracts are easy to change (reorganizing, rewriting) between institutions where property rights, conventions and authorities are other part of institutions which are hard to change overtime. Contracts are structured where both parties weight in there possible options, hence problems will be encountered in contracts if there is deception, where one could take advantage of the other due to information asymmetry on the agreement outlined with the anticipation of higher gains. The consequence will be enforced by the existing law requiring compensation to the other involved party (Brousseau & Glachant, 2008).

There is a clear distinction between organization and institutions. Organizations are the "players of the game" while institutions are "rules of the game". This is a definition given by Douglas North (North, 1990).

When organizations expand the extra transaction cost due to expansion increases until it reaches the neutralizing point naturally financed by organizational expansion (Coase, 1937). Human behaviour is diverse for every choice and opportunity creating inefficiencies because there exists cost of negotiation to reach an agreement with information expansion (Milgrom & Roberts, 1992).

External agency involvement seems to be necessary with a public good that has a limited supply i.e common pool resources because control from exhaustion is compulsory to guarantee collective action (Hardin, 1968). Local collective action with accepted council would be much more efficient and cost effective rather than external agency involvement because of social ties (Wade, 1987).

2.3 Common pool resources and equity

The most common problem in common pool resources is equal distribution among the beneficiaries. The introduction of institutions formal or informal is essential element with the resources that require proper care. Common pool resources are resources that require appropriation and provision decision because utilization without a set of rules and regulations that fix appropriation and provision problems will lead to conflict among beneficiaries due to their finite nature (Wade, 1987). Existence of this institution may yield an equitable distribution of resource. Informal institutions must

typically be made up of the collection of beneficiaries, who work for individual gain with combined action. The introduction of institutions has a paramount importance in providing joint benefits among humans to ensure improve welfare (Dudu & Chumi, 2008). The solution of the equity problem in water management is questionable without the involvement of institutions

Farmers in irrigation which are close to the starting point of water outflow commonly known as upstream farmers should have proper verdict. Hence they are responsible for equal sharing of the water among users (Campenhout, et al., 2012). This appears to be unacceptable because upstream users are not benevolent in reality (Ulsido & Alemu, 2014) A proper institution with strong influence on distribution, provision, continual management and evaluation is perquisite for irrigation systems in water.

Bargaining is one of the methods that reduce the equity problems in the distribution of water among upstream/ head end framers and downstream/tail end farmers by reducing the difference in quantity of water allocated for downstream users.

2.3.1 Suggestions to improving equity of distribution

(Ostrom & Gardner,1993) formulated rotational rules to improve equity in water distribution among upstream and downstream beneficiaries with two rotation rules ‘ Rotation rule A is based on the assumption that in odd number of years water first go to tail enders and in even no of years water first reaches the head enders. Both enders will work side by side for any days devoted to maintain the system.’ Rotation rule B is based upon the same principles as A but the only difference is in years turn to days.

The involvement of bribing an official for water release was the main problem irrigators faced. In their collaborations farmers use to hire officials for the distribution of water with an agreement on equal distribution among their geological placement. The officials responsible for distribution were bribed by the upstream farmers on the actual distribution because they would not pay them if they reveal what happened to the downstream farmers (Wade, 1982).

Distribution among beneficiaries being equal is a very difficult objective to address. Management must be as close to as possible to equal distribution. When talking about common pool resources that must be available to every beneficiary when we consider the issue of equity. Hence equity can only be maximized with collaboration and strong social capital with the existence of local institutions being similar to appropriation and provision rules (Ostrom, 1990).

2.4 Collective action in management of common pool resources

Collective action is harmonization of members on an objective or a set of objectives. The main goal of collective action is to satisfy the common interest of members of the group given the common pool resources (Wang, et al., 2012).

According to Robert wade “collective action is an action by more than one person intended to achieve a common goal or satisfy a common interest (that is, a goal or interest that cannot be obtained by an individual alone).Achievement means that a public or collective goods has been provided” (Wade, 1987).

There are large scale and small scale collective actions with different approaches. It was identified by (Uetake, 2015) that smaller collective actions operate where farmers work together among themselves and those around them without any involvement of any institution. He also identified the three others types of collective action as large scale collective action that are organizational style (where every participant is a part of an organization with rules and regulations), external agency led (every participant is controlled by external agency), cooperation between external agency with farmers (the combination of the above two).

According to Freeman (Freeman , 1990), in collective action for managing a common pool resource cheating by one individual in cooperation with the assigned objective or agree way to go in utilization of the resource will result in he/she enjoying larger share of benefit compared to the users that abide the rules and regulations resulting in high and continuous cost in management and monitoring of CPR.

Inequality in wealth among beneficiaries can have two paradoxical effect on collective action in management of common pool resources. First we will have rich participants who do not worry as much as poor participants in the proper management of CPR. Because the poor participants may be reliant on their livelihood compared to the rich which will give them higher incentive to participate in collective action. Second the richer participants might stimulate the poor participants to participate in collective action because the wealthier participants acknowledge cooperation is essential for higher welfare among the community with a consequence of poor participants taking advantage by free raiding on use of CPR (Platteau & Baland, 1999).

2.5 Water allocation in irrigation systems

In irrigation system according to Freeman (Freeman, 1990), maintaining irrigation systems is a difficult task with requirement of a long period of time and requirement of high discipline from farmers with temptations to cheat on their water use.

Seasonal conditions decide the pricing of water in an irrigation. Cooler seasons or times with larger amount of rainfall and small need of the water for an irrigation reduce the demand for water in irrigation activities for crop production making the price lower in this times. On the other hand in hotter seasons or times with smaller rainfall from the environment the demand for water arises hence there are great need of supply of water for irrigation farmers in production of crops (Appels, et al., 2004).

Water resource used in an irrigation scheme has a price which will depend on the different pricing methods used by the providers. According to (Tsur & Dinar, 1995), the pricing method that are listed below confirm that they can achieve efficiency. There are three pricing methods. Volumetric pricing where farmers pay for the amount of volume of water they used for irrigation, per unit area pricing where farmers pay a fixed amount for each irrigated hectare, Output pricing where farmers pay for each output unit.

2.6 Irrigation systems in Ethiopia

Based on the Ministry of Water Resources (MoWR) classification cited (IWMI, 2007), in Ethiopia private commercial farms changed hands to state ownership due to

liberalization since 1990s. As a result the government has been engaged in expanding the participation of farmers in irrigation schemes for better outcome in agricultural production.

According to (IWMI, 2007), classification of irrigation schemes in Ethiopia is based on size of the command area they occupy. The present irrigation schemes are large scale, medium scale and small scale. If the command area occupied is greater than 3000 hectares we are referring to large scale irrigation scheme. Medium scale falls within a range of 200 to 3000 hectares, whereas small scale irrigation schemes are characterized by command area of below 200 hectares. The type of management according to scale of the scheme is different whereby large scale scheme is managed by state owned enterprises, medium scale managed by irrigation cooperatives and small scale schemes are managed by local water user associations (Hagos et al, 2009).In 10 regions out of 11, 791 irrigation schemes exist in the country. The Amhara region possess 310 schemes which is the highest number of schemes compared to the others. Benishangul Gumz has 2 schemes (IWMI, 2007).

There are many challenges persisting that hinder development of irrigation in the county. Among those lack of awareness in irrigation water management that leads to insufficient community participation is the main one. Propriety are given by the government in irrigation development through creating farmers training centers that provides farmers with essential skills in irrigation (Haile & Kasa, 2015). One of the compulsory skill is improvement of collective action among farmers.

Collective action for developing small scale irrigation schemes has paramount importance with changing rainfall patterns and scarcity of irrigation water distribution (Amede, 2015).

2.7.1 Empirical review on collective action for common pool resource

The method used in identifying the determinants of larger scale collective action in agricultural natural resource was semi structured questionnaire. The group participants and officers were from four case study areas of beaver hill initiative, agri-environmental group planning in Saskatchewan, North Otago Irrigation Company and

East coast forestry project. It was found out that three factors were there affecting large scale collective action. To identify the issues of common pool resource based on geological boundaries, support from governmental and non-governmental bodies financially and through leadership and rules are important to manage the collective system with monitoring and sanctioning, conflict resolution system and nested government (Uetake, 2015).

Collective action determinants and its effectiveness in communal grazing land management was the main objective of the study after collecting data from 100 villages in northern highlands of Ethiopia. In this study by using five dependent variables where a probit regression was ruined to determine whether communities pay for guard, whether penalties were established and whether any violations occurred in 1988 which is the reference period for the study, followed by Tobit regression on area of restricted grazing land per household and contribution per household for grazing land management. Since there was a censored survey data a Tobit regression was chosen than probit. Variables that were considered to affect collective action are no of total household in the village, restricted grazing promoted by external organization, heterogeneity of oxen ownership of the community, total number of local organization operating in the village, distant to market from the village, involvement of external organization, whether cattle rearing was the second most important source of livelihood and total area of the community (Gebremedhin, et al., 2004).

The results of the econometric analysis found out communities were more likely to pay for guard at intermediate population than low or high population levels, violation of use restriction are least likely to occur at intermediate population. The involvement of external organization in promoting restricted grazing land areas reduced the likelihood of communities paying for a guard whereas it has positive effect on household contribution for grazing land management. Communities that are more distant from markets are more likely to pay for a guard and to establish penalty system for grazing land management. Whether or not cattle rearing was the second most important source of livelihood in community did not affect any of the indicators of collective action significantly. Heterogeneity in oxen ownership tends to diminish collective action. Heterogeneity increases the likelihood of violations of restrictions

and regulations. Heterogeneity explained household contribution for grazing land management negatively but was statically insignificant. It was also found out total area of the community has positive effect on area of restricted grazing land per household (ibid).

Exploration of how resource characteristics and the institutional context affect people's behaviuor in common pool resource considering mangrove and the cockle fishery was the main objective of the research. By constricting a semi-structured questionnaire to obtain qualitative and quantitative data for creating measures of collective action. 12,433 samples were collected from Muisne, Las Manchas, Puerto Hualtaco, Isla Costa Rica from beginning of 2009 to end of 2010.OLS regression was used to measure response variable MEANTUB(mean shell length in each fishers catch) with explanatory variables members of association, age of fisher, size of the community, lunar cycle (spring tides), fixed effect to control for unobserved geographical heterogeneity, no of cockles used for Mari culture and trust that other users comply with rules in use (Beitl, 2014).

It was found out that size of community, lunar cycle(spring tide), fixed effect to control for unobserved heterogeneity and number of cockle used for Mari culture were statistically significant affecting the explanatory variable MEANTUB negatively, positively, negatively, negatively respectively with all other variables being insignificant. The independent cockle collectors because of trust and not being invited in the reforestation program do not contribute to collective action. At the same time they were criticized as a free raiders on the hard work of the collective effort by their lack awareness or customary rules in fishing (ibid).

Using a cross sectional survey of members and non-members of farmers group to determine and assess impact of collective action of framers in Kenya, 444 respondents were selected using stratified random sampling. 137 were non-members, 201 group members and an additional 106 farmers were included to have a more robust control group. Binary choice probit regression model was used where the response variable was to investigate farmers choice whether to join the group with explanatory variables size of the land holding, size of the land holding squared, property title for land, lagged

size of banana plantation, lagged area squared, log of value of agricultural equipment, household owns donkey cart, household owns car, pick-up or motorbike, no. of cattle owned by household, age of household head in years, age of household head in years squared, head has primary education or above, female headed household, number of household members, household owns mobile phone, household participates in other groups, household has access to credit, distance to nearest paved road in km, distance to nearest paved road in km squared, household member has nonfarm employment and household member has nonfarm self-employment. To generate the effects of group membership is modeled in two stages, stage one propensity score matching from probit model. Stage two calculation of the ATT (average treatment effect on the treated) using matched observation of members and non-members (Qaim & Fischer, 2012).

It was found out the size of land holdings has a positive and significant effect increasing the predicted probability of membership by 4.3 % points with as additional acre of land owned. The predicted probability of membership is decreased by 0.2 % points by size of land holdings squared. The log value of agricultural equipment has a positive and significant effect. Age of household in years, household owns a mobile phone, access to credit, distance to near paved road and self-employment were found to be significant affecting probability of membership positively. However distance to near paved road squared did negatively. The outlined points were results of the restricted sample which makes it different from the full sample because it doesn't include the control group regions. Meanwhile in full sample analysis which was estimated to calculate individuals propensity scores, few of the results changed. All the listed variables above were significant except agricultural equipment and age of house hold in years. The ATT calculated resulted shows four results. Forty percent of the members didn't participate in collective marketing rather individual marketing, marketing through the group yields higher price than individuals, no change in harvest for the group members who market through the group, and a significant decrease in harvest for members who market Individuals, for collective marketers of banana total income from banana has a significant increase resulting in improvement in welfare for collective marketers. While this doesn't appear for individual marketers (ibid).

The Robustness of estimated ATTs in the probit model was tested. The ATT results for members marketing collectively from the base model and two variations. First variation is reduced probit model which excludes no of cattle's owned, value of agriculture equipment, means of transportation and mobile phone ownership. Second variation uses extended model which includes risk attitudes, cash crop production, dummy measuring the efficiency of banana supply chain in sub-location, ownership of irrigation equipment's in five years. It was found out that signs of ATT are mostly unchanged although significance level varies. For example total banana income is significantly different between members and non-members through the three models even though total annual income was only significant for the base and reduced probit models (ibid).

A study was conducted in Tigray about collective action in 1998/99, on a survey taken from 50 tabias using stratified random sampling. The first objective was to evaluate the nature and impact of community management in the regeneration of woodlots in Tigray. Second objective was to assess the determinants of collective action and its effectiveness in managing community woodlots. Collective action was considered to be affected by factors like population density, agricultural potential, market access involvement of external organization, village level management and size of resource. Tobit regression model was used to explain collective labour investment and survival rate. Binary probit choice model was used to explain whether the community pays for the guard or whether there were violations of restrictions. Furthermore OLS regression was used to measure tree planting density (Gebremedhin, et al., 2003).

The findings were labour intensity of woodlots management is positively associated with population density with parallel increase in both variables at first and when the population density reaches its maximum there will be negative relationship that follows from then on. The community pays for a guard, violations of restrictions and survival rate of trees also show the same relationship as the above one and are statically insignificant while planting density and population density were significant. Market access with more remote communities provide greater collective labour input, densely planting trees and obtaining higher survival rates. The presence of external organization as indicated by whether the woodlots was promoted by external

organization has a negative association whether the community pays for the guard and with tree survival. Unexpectedly collective action was more effective on tabia managed woodlots than village managed woodlots. Lastly, area of woodlots had a statically insignificant relationship impact on measurement of collective management and effectiveness of woodlots (ibid).

Participating in collective market in the study by (Qaim & Fischer, 2012) is a choice. It only depends on participation and not participation in collective marketing. When it comes collective action participation in common pool resources there are numerous factors that should be considered according to the type of CPRs. The study by (Gebremedhin, et al., 2003) and (Gebremedhin, et al., 2004) considered activities that represent collective action but didn't consider correlation among those activities. The study by (Uetake, 2015) gives us qualitative explanations which are very important but could be supplemented by quantitative analysis while quantitative analysis on large scale collective action could be difficult.

2.7.2 Empirical review on collective action for irrigation water management

A study was conducted in South Africa after collecting cross sectional data from 307 respondents where 246 were scheme members and 61 non-members in Mooi River Irrigation Scheme. The main objective was to know what factors determine participation and intensity of farmers in collective action for irrigation water management in a small scale irrigation scheme. Using principal component analysis for summarizing few factors that capture the maximum possible variations among the listed dependent variables, a linear combination of variables were derived from the original dependent variables. Then Tobit regression was used to measure the determinants of participation and an ordered probit regression to measure individual intensity of participation in irrigation water management. It was found out that farmers who obtained high income from the irrigation activates participate more than their counterparts and farmers who received irrigation training participated more. Other important variable were farmers with larger land coverage who have a positive relation to participation maybe due to their request of water to cultivate their land compared to the farmers with smaller land (Muchara, et al., 2014).

Intensity was highly determined by the modality of water supply the farmers receive, agrarians that used pumps incurred more cost than that of gravity based making them less intensive. Another important variable was the education level of a farmer which was found to be positively related to intensity and engaging in the local water user associations for development of collective action. All the explanatory variables in the study showed results that is expected. Assessing the objectives with same modality of water distribution may shade different light on beneficiaries' reaction to collective action. (ibid).

With an objective of assessing factors that influence the likelihood of collective action among large and different groups of irrigation systems, OLS regression was used to estimate the effects of water scarcity proxied by crop intensity, distance to market, age of irrigation associations, group size, origin of irrigation activity, average size of irrigation farm, gender (proportion of women in irrigation activity) and government (governance structure of irrigation activity) on monetary free riding. Logit regression model coded 0 if at least 75% of irrigation association members contribute labour voluntarily based on the attendance records of association and 1 otherwise was the second proxy measure in free riding in labour contribution with the same explanatory variables. 1958 observations were considers from 196 large scale public irrigation system with an assembled multivariate cross sectional data set. Crop intensity, group size, farm size, government structure were found to be statically significant at 5% of level of significance while all other variables were insignificant except access to market which was statically significant at 10% level of significance on the likelihood of free raiding in irrigation setting. In the logit model only age of the irrigation activity and distance to market were found to be statically significant (Araral, 2009) .

(Gulati, et al., 2002) undertook a study using separate key informant interview and semi-structured interview taking nine randomly selected sites and three purposively selected sites in two irrigation systems. To assess collective action for managing resources in Indian states of Rajasthan and Karnataka, logistic regression model was used in two stages. First stage analyzes the likelihood of some form of water user's organization as a function of water supply, size of water association, social

heterogeneity, access to market, external organization and leadership. Second stage examines likelihood of collective maintenance as a function of (predicted) organizations and other factors. Dummy variables for irrigation systems that are four (IGNP, CHAMBAL, KRS, UKP), dummy variables for head and tail which proxies water scarcity, size of hydrological unit, distance to market, social capital of the minors command indicated by the presence of cooperatives and temples in the minor command final variable was leadership potentials indicated by no of college graduates and dummy variable for influential person was used to determine probability of farmers irrigation organization.

In the first stage logic regression, it was found out coefficients for system dummy variables were significant while the head or tail variables were not significant. Access to market had a significant but negative effect. The number of temples in the village of the command area does have a significant and positive influence on likelihood of organization for irrigation while the cooperatives in the command minor area was not significant. Among leadership variables both the presence of college graduate and influential person have a significant positive effect on irrigation organization. In the second stage logic regression the model of collective action included predicated value of whether there would be a water user association (WUAp). All the variables were found to be insignificant except two variables the predicated value if irrigation organization (WUAp) which has a positive effect and villages which was the indicator of social size and social heterogeneity. Most important variables considered were insignificant (ibid).

For a transitional economy in the Bulgarian irrigation sector identifying constraints of collective action was the aim of the study. Qualitative research method being predominant than quantitative analysis 17 villages were used for the case study. Selection of farmers by random sampling for an interview to authenticate key person's interview and information of expert's interview results. Participative observation combined with qualitative interview was used resulting a triangulation of data from multiple sources to do the analysis. In the 2nd phase a standardized questionnaire was conducted where 2/3 were open ended questions by interview guideline. In 3rd phase finding from 2nd phase where incorporated for another phase standardized

questionnaire. The finding of the study was that deteriorating of social capital by specific actors with characteristics that constrain the possibilities of collective action. Social capital is key component in collective action for common pool resources in the long term. Institutional management preferably state institution of irrigation sector with high participation from farmers was medium term solution (Theesfeld, 2004).

To realize what kind of institutional arrangement is required for water resource a case study was conducted in southern Zimbabwe in a district called Chive. Key informant interview, participation observation and participation rural appraisal was the methodologies used to address the objective. Privately owned and community owned water sources were under the study. Common pool resource management was assisted by social capital was a key finding. This social capital were structured in an uncommon way i.e. rules and regulations were unwritten but known by the governing bodies and the beneficiaries. Unwritten rules endorsed social capital implicating the bond found by beneficiaries were much greater community built institutions. (Nemarundwe & Kozanayi, 2003).

To find out the determinants of collective action and effectiveness in irrigation water management in Astbi wemberta (Tigray) and Ada'a (Oromiya region) data was collected from 169 groups. To measure collective action four univariate probit selection model and one OLS regression was used. The results show average value of a group member contribution for the resource management run by OLS regression and if there are guards protecting the irrigation site modelled by a probit selection were affected by mainly group and scheme level variables. Whether a group of members contribute for guards and if there is a water distribution in the irrigation scheme were affected by group level variables, farm level variables, village level variables and scheme level variables while whether group members contribute for the water distributer was affected by farm level and village level variables. Failure of collective action dependant variables were modelled by OLS and Tobit decomposition. Frequency of violation occurrence modelled by OLS was affected by group level variables, farm level variables and village level variables. Number of conflicts occurred modelled by tobit was affected by mainly group level variables and village level variables, scheme level variables. Effectiveness of collective action represented

as number of penalty system exercised was modelled by a tobit where scheme level variables and village level variables affected it (Deribe, 2008).

The study by (Muchara, et al., 2014) used PCA to capture the variation in dependent variables would not show what determines each dependent variables separately. Cost and access to information capturing variables inclusion would have given better results. The studies by (Nemarundwe & Kozanayi, 2003) and (Theesfeld, 2004) showed the dominant value of social capital using qualitative analysis. The study by (Gulati, et al., 2002) considered position of block made the analysis better even if they were insignificant assess factors that affect collective action management. This research uses a larger observations that produced similar results with literature (Araral, 2009). Collective action should be modeled with available dependent variables that represent it. It should be acknowledged this measurements are correlated. Participation in one activity affects participation another activity. The study by (Deribe, 2008) didn't consider this assumption.

Chapter 3 Source of data and methodology

3.1. Formulations of the questionnaire

Before going to the study site, developing a household level questionnaire that accurately captures details required for the study was crucial. The questionnaire was tested to make sure it is appropriate for this study and to see the reactions of respondents. A pre-test was conducted in Mekki irrigation scheme where male headed and female headed households were involved in the pre-testing. It was found out the questionnaire was easy to understand needing only certain modifications.

Modification on some of the questions was necessary to capture an accurate data on all the variables that are outlined to measure determinants of participation and intensity of collective action. Recalling some of the questions included were difficult for the respondents hence answers were not available. The pre-test was a good experience and helped to improve the quality of questionnaire and made questions easy to understand and give accurate responses.

3.2 Description of the study areas

Dura, Dibdebo and Laelay Logometi are kebeles of the study found in Central Tigray zone, in the northern part of Ethiopia. Dura is located in wereda called Semen Maychew which is 10 km from the city of Axum on the way to Shire. Axum is a city that is 942 km away from Addis Ababa. Laelay Logometi is located in a wereda called Adwa which is 30 km away from the city of Adwa on the way to Tembain. Dibdebo is located in a wereda called Aferom which is 28 km away from the city of Adwa on the way to Adigrat. Adwa is 927 km away from Addis Ababa. The farmers in the study areas practice mixed farming system. They grow crops and rear livestock as their main source of livelihood. The farmers in the study sites use irrigation plots as well as rainfed plot to produce crops.

Table 3.2 Absolute location of study site

Study site	North Coordinate	South Coordinate	East Coordinate	West Coordinate
Dura	14° 16’ 41”	14° 10’ 05”	38° 69’ 98”	38° 62’ 95”

Laelay Logometi	14° 17' 97.43"	14° 09' 02.23"	39° 02' 52.67"	38° 96' 82.31"
Dibdebo	14° 27' 69.32"	14° 26' 21.55"	39° 09' 28.96"	39° 07' 61.78"

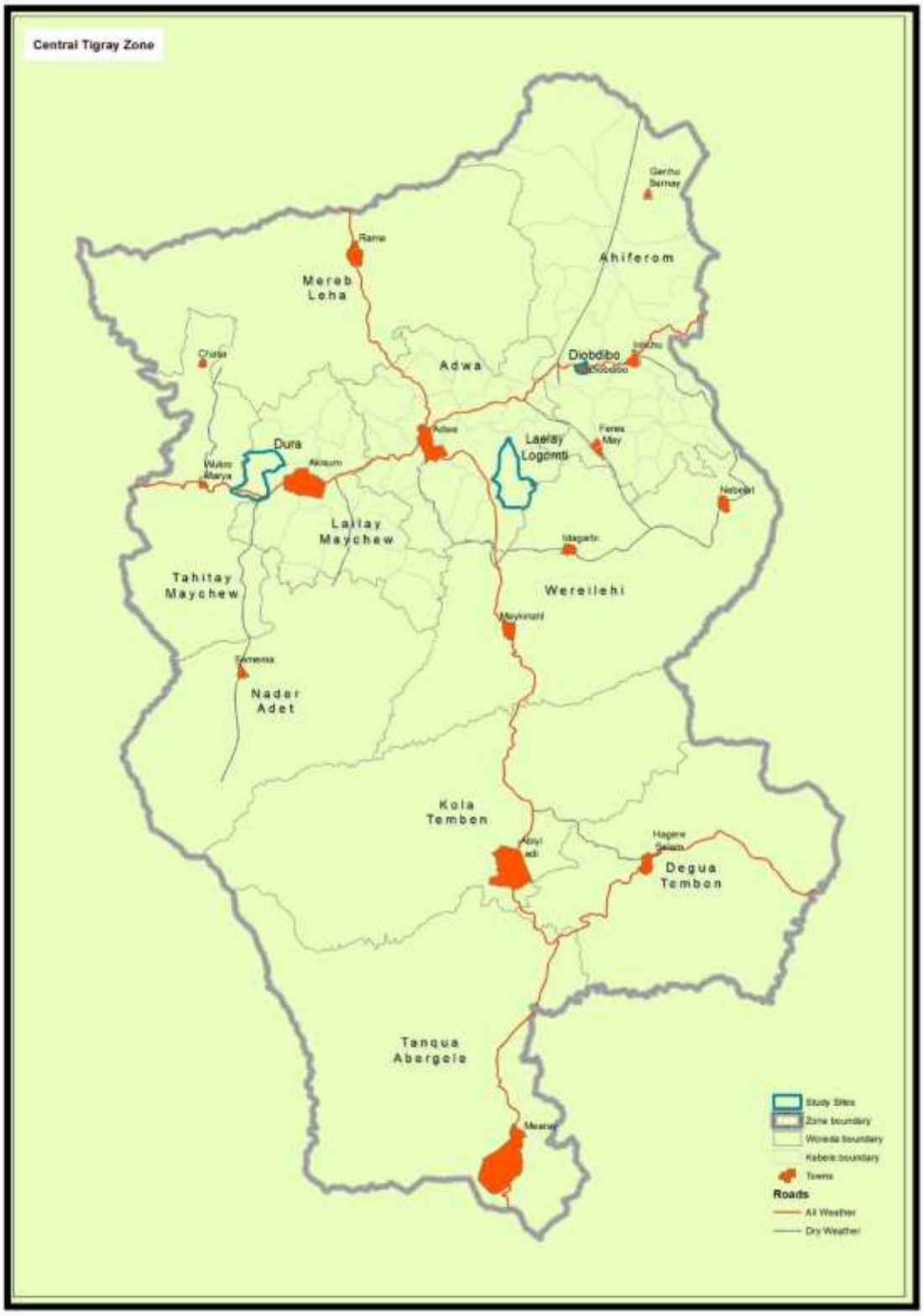

Figure 3.2 Map of study kebeles in Central Tigray, Ethiopia.

Firstly, the sample population collection is based on irrigation farmers who use only dam as their source of water distributed by means of gravity to their farm. Other types of irrigation systems like pumping of water from wells and any other water source and diversions were left out. Three study sites were found using canal irrigation. By implementing multistage sampling on a set, identification of the irrigation farmers from non-irrigation farmers was made from three kebeles that used canal irrigation. It was found out that Dura, Dibdebo and Laelay Logometi have 193,632 and 268 farmers who are engaged in irrigation farming from canal irrigation using gravity. The development agents information on farmers having many plots of land that is located in multiple of the stratas was wrong for this study hence there should be another stage where farmers who are included must be found only in one strata was vital for selection of sample population. The stratas are head ender, mid ender and tail ender.

By carefully working with the development agents to select the farmers based on the stratas, farmers having irrigation plots in two strata were eliminated. Because they are not representative of a single strata, elimination of these group is to avoid biased participation of an individual farmer based on the different locations of irrigation farms resulting an average outcome. Dura had 153 framers who qualified for the selection criteria set to be a sample population. The sample population of Dibdebo and Laelay Logometi is 165 and 180 irrigation farmers respectively.

Selecting the 240 observations from four kebeles[1] was the original plan in the proposal but after visiting the sites we selected two of the kebeles who use water pumping from wells for their irrigation farms. This kebele's had to be excluded because they can't be integrated in the three stratas. Dibdebo was then selected as a replacement for the kebele's excluded. To make sure the data is as much representative as possible 80 households from ever kebeles were taken as samples.

When selecting the samples according to stratified random sampling, the sample a strata of three categories that represent their location (position of block) of the

[1] Kebele is the smallest local level administrative unit

household's farm where the distance from the starting point of the dam is categorized as head, the next to it is mid and the last to receive the water were the tail farmers. Classification of the location according to their position of block was made in consulting development agents of each site.

Separation of samples form population sample was made by putting all the observations in the population sample in alphabetical order and selecting 80 representative samples from each site conferring to their actual proportion of placement. Selection of three enumerators from every site with one supervisor took place. The supervisor working together with development agents made choice of enumerators based on their experience in data collection, education and their understanding of the survey. Selected enumerators were given a one day training particularly on understanding the questions fully in order to explain it clearly to respondents before starting the survey. They all conducted pretest to check if problems existed in collecting the data, and learned how to make questions unbiased and non-leading.

The survey was completed with full success were the assumption of farmers doing repairs for Canal in 2007 couldn't be measured hence there was no repairs done in Dibdebo and Laelay Logometi reducing the participation measuring variables from four to three. Selection of the year (2007) where cross-sectional data was collected couldn't be changed because accuracy of respondent's would deteriorate.

3.3 Descriptive analysis

Descriptive statistics of the independent and dependent variables for the data is show in the table below.

Table 3.3 Description of variables

Explained Variables		
Measurement of Participation	Proportion of yes	Yes
Did you clean dams in 2007?	.8417	202
Did you contribute funds for irrigation activities in 2007?	.8583	205
Did you attend meetings by WUA in 2007?	.8958	215

Explanatory Variables	Mean	Min	Max
Age of household head in years	54.36	25	90
Sex of household head (male=1, female=0)	0.704	0	1
Labour force	3.104	0	8
Education of household head	2.53	0	12
Annual income of household head from irrigation	3258.08	0	46000
Ownership of mobile phone by household head?	.4625	0	1
Ownership of Television by household head	.1167	0	1
Ownership of Radio by household head	.171	0	1
Size of irrigation farm in hectare	.11855	0.15	0.786
Size of rainfed farm in hectare	.11447	0	0.625
Distance to input market from homestead in minutes	17.8167	0	120
Distance to all weather road from homestead in minutes	30.40417	1	180
Distance to Crop selling market from homestead in minutes	79.542	0	270
Extension contact in irrigation farming	0.3	0	1
Extension contact in rainfed farming	0.29	0	1
Membership in community based organization	0.5292	0	1
Age of dam	12.3875	3	18
Perception of rainfall adequacy	0.4167	0	1
Position of block	Head	Mid	Tail
	95	67	78

Source: Survey 2016

3.3.1 Descriptive analysis of explained variables for Kebeles

After going to the sites it was found out that there was no repairs done in Dibdebo and Laelay Logometi for the study period (2007). This reduces the explained variables to three.

Dura had repairs done in 2007 and all the other explained variables are listed below.

Table 3.3.1.1 Dependent variables for Dura

Measurement of participation	Yes	No
Did you clean dams in 2007?	80	0
Did you repair dams in 2007?	80	0
Did you contribute funds for irrigation activities in 2007?	80	0
Did you attend meetings by WUA in 2007?	80	0

Source: Survey 2016

Laelay Logometi had no repairs done in 2007. The data is as follows

Table 3.3.1.2 Dependent variables for Laelay Logometi

Measurement of participation	Yes	No
Did you clean dams in 2007?	64	16
Did you contribute funds for irrigation activities in 2007?	66	14
Did you attend meetings by WUA in 2007?	64	16

Source: Survey 2016

Dibdebo had no repairs done in 2007 the data is as follows

Table 3.3.1.3 Dependent variables for Dibdebo

Measurement of participation	Yes	No
Did you clean dams in 2007?	58	22
Did you contribute funds for irrigation activities in 2007?	59	21
Did you attend meetings by WUA in 2007?	71	9

Source: Survey 2016

3.3.2 Descriptive analysis of explanatory variables

3.3.2.1 Household level variables

Sex: - The cross-section data collected show 70% male and 30% female respondents across all the three sites. Where Dura had 77.5% male and 22.5% female respondents, Laelay Logometi had 76.25% male and 23.75% female and Dibdebo had 57.50% male and 42.50% female respondents as sample population.

Age: - The mean age of household head for the study sites was 54. The highest percentage of age concentrated for household head was at 50. 84% of the respondents in the study sites were in between the age of 40 to 80 showing experience in farming. The mean age for Dura respondents was found to be 54, the mean age for Laelay Logometi household head was 49 and Dibdebo household heads have mean age of 59. This data from each Kebele shows that all of the household heads who are responsible in making all of the major decisions are middle age adults. 74% of household heads in Dibdebo are between the age group 40 to 70. 71% of household heads in Dura are between the ages of 38 to 62. 74% of the household heads in Laelay Logometi are between the ages of 35 to 63. All of the study sites household heads are in classified as adults.

Labour force: - The mean labour force available in a households across all sites was 3.1. The mean labour force for Dibdebo was 2.66 being the least of the three whereas Laelay Logometi and Dura had a labour force available 3.1 and 3.57 for households selected to be respondents. This indicates the labour force available within the household could have two effects on participation. If the dependents who are under the age of 15 are in a higher proportion compared to the labour force the bigger the family the lower tendency for participation. This can be explained as there is a need for hired labour which increases cost of irrigation farming. On the other hand. if things are reversed to what is outlined above the tendency for participation will be higher with family member's participation for irrigation and helping out with certain tasks. 31.25% of the sample population has equal number of family size and active labour force (between the ages of 15-64) whereas the 68.75% of the households have a greater family size than active labour force.

Education: - 52.8% of the respondents are illiterate with education only in writing and reading the local language. Whereas 47.2% of the respondents which are the other half who took only primary school education.10.83% of households were educated up to fourth grade. 61.25% of households in Dura only received education in writing and reading of the local language. 1.25% of the respondents from Dura received secondary school education.33% of households in Laelay Logometi have education in writing and reading of the local language.10% of households in Laelay Logometi have secondary school education while the rest had a primary school education. 97.5% of the households in Dibdebo have primary school education while the remaining 2.5% had secondary school education. Dibdebo has farmers better educated relative to the other kebeles showing education is a key determinate. Dura and Laelay Logometi have relatively younger household heads with higher social ties due to size of irrigation farm in their PA(peasant association) compared to Dibdebo

Income from irrigation: -The mean annual income from irrigation for all the study sites was found to be ETB 3258. 68.75% of the respondents from all the study sites have an income range of ETB 1,000-46,000. The mean annual income for respondents is ETB Dura 5772. 86.25% of the respondents earn income in a range ETB 2,000-24,000. The mean annual income for respondents in Laelay Logometi was ETB 2125 birr.75% of the respondents in Laelay Logometi earn an income from irrigation in the range ETB 1,000- 18,000. The mean annual income for respondents in Dibdebo was

ETB 1876. 33.75% of the respondents in Dibdebo earn an income from irrigation in the range of ETB 1,000- 46,000. This show Dura earns more income for irrigation with a lower highest income compared to respondent in Dibdebo.

Ownership of Mobile Phone: - 46.25% of the household heads from all of the study areas own mobile phone. This is less than half of the sample population so there should be another source of information obtaining device should be included in this study as variables. Ownership of television and radio were then included in the analysis to capture access to information. Dura with the lowest ownership of mobile phone shows 13.75% of the respondents own mobile phone. Half of respondents in Laelay Logometi own mobile phone while 75% of the household head in Dibdebo own mobile phone.

Ownership of Television: - Only 11.67% of the sample population own television**.** Households in Laelay Logometi have the lowest ownership of television among the three sites with 3.75% ownership and Dura follows with 6.25%. While 25% of the respondents in Dibdebo own Television.

Ownership of Radio: - Only 17.1% of the sample population owns radio. Households in Laelay Logometi have the lowest ownership of radio among the three sites with 11.25% ownership and Dura follows with 16.25%. While 23.75% of the respondents in Dibdebo own radio.

3.3.2.2 Farm level variables

Size of irrigation farm: - The biggest irrigation farm owned by a respondent is 0.78 hectare in three study areas. A way of measuring land in the area is known as Timad. 25% of the respondents own land more than 1 timad (1 hectar is 0.25 timad)**.** The mean size of irrigation farm in Dura is the highest among the 3 sites with 0.207 hectar. Following Dura comes Laelay Logometi with mean size of irrigation farm 0.09 hectares. Dibdebo has the lowest mean irrigation farm size of 0.054 hectares.

Size of rainfed farm: - The biggest rainfed farm owned by a respondent is 0.625 hectare in three study areas. 30.83% of the respondents own land more than 1 timad**.** The mean size of rainfed farm in Dura is the highest among the 3 sites with 0.20707 hectar. Following Dura comes Dibdebo with mean size of irrigation farm 1.1577 hectares. Laelay Logometi has the lowest mean irrigation farm size of 0.11135 hectares.

3.3.2.3 Infrastructure level variables

Distance to all weather road from homestead in walking minutes: - For the three sites the longest distance a respondent has to travel is 180 minutes with the shortest being one minute. 50% of the respondents in Dura takes them from 10 to 90 minutes to travel to all weather road. 75% of the respondents in Laelay Logometi takes them from 40 to 180 minutes to travel to all weather road. Dibdebo has the shortest distance. For respondents (87.5%) to reach all weather road they walk less than 10 minutes.

Distance to input market from homestead in walking minutes: - The longest walk for 3 of the respondent across all the study site was 120 minutes with one minute being the shortest for getting to the input market. Dura which has the closest distance of input market, 96.25% of the respondents have to travel from 10 to 50 minutes to reach the input market. Dibdebo comes next with 48.75% of its respondents taking 10 to 25 minutes to reach the input market. However the three respondents who took 120 minutes to reach input market are in Dibdebo. 77.5% of the respondents in Laelay Logometi took from 10 to 60 minutes to travel to input market in the kebele.

Distance to crop selling market from homestead in walking minutes: - In the study sites every farmer sold his/her crops produced to their closet market which is market in tabia. 50% of the respondents had to travel from 95 to 270 minutes to sell their crops. 86.5% of the respondents in Laelay Logometi had to travel from 30 to 270 minutes to sell their crops, this site has the furthest crop selling market across the three. Dura comes next with 75% of the respondents had to travel from 90 to 160 minutes to reach the crop market. Dibdebo has the closet crop market with 95% of the respondents had to travel from 5 to 120 minutes.

3.3.2.4 Institutional level variables

Whether the household has access to credit: - All of the respondents across in the study sites have access to credit.

Extension contact in irrigation farming: - Trainings programs are given to respondents every year by development agents in farmers training center. These trainings are considered as a key variable as extension contact in irrigation. 30% of the respondents have taken irrigation training from all the sites. Dura come first with 70%

of its respondents taking this trainings. Laelay Logometi and Dibdebo respondents have a very low attendance of irrigation farming training with 11.25% and 5% respectively.

Extension contact in rainfed farming: - The same kind of trainings but on rainfed farm plots. Row cultivation, use of selected seeds and proper and timely use of fertilizers are trainings given in rainfed farming. 29% of the respondents have taken rainfed farming training from all the sites. Just like irrigation attendance by respondents Dura comes first with 73.75% of the respondents participating. Dibdebo and Laelay Logometi have the same low attendance as above with 8.75% and 5% attendance among respondents respectively.

Whether a farmer is a member of community based organization: - According to theory and intuition social ties would be much greater when irrigation farmers belong to community based organization since their interaction overall will be greater. 52.92% of the respondents do have a membership in community based organization across all sites. All the respondents in Dura are a member of an external organization. Dibdebo has 33.75% of its respondents being a member in such organizations. With a low 25% Laelay Logometi becomes the last one with a few respondents being a member.

3.3.2.5 Scheme level variables

Whether the rainfall is adequate for the irrigation farmer (his or her perception): - In all the study sites 41.67% of the respondents acknowledged according their perception the rainfall of 2007 was adequate for the farm plots. 60% of Dura respondents and 53.75% of Laelay Logometi respondents thought that it was adequate. Dibdebo has the lowest with 11.25% of the respondents perceiving the rainfall as adequate.

Age of dam: - the dam in Laelay Logometi is the newest among all with only 3 years. Second comes the dam in Dibdebo that is 16 years old. The oldest id Dura with 18 years. Age of dam shows growth of farmers with improved use of water from the dam.

Dummy variable for position of block: - This variable represents the three strata's where the respondents were selected from. According to their position of block and the actual proportion of irrigation farms. In Dura 40% of the respondents were taken from the tail end, 35% of the respondents were taken from mid end and the remaining 25% from head end. In Laelay Logometi with equal 40% settlement of head and tail ender farmers the remaining 20% of the respondents were from the mid ending position.

Dibdebo has a 23% and 22% tail and mid enders respectively with the majority 55% of head ender respondents.

3.3.3 Credit market for the study sites

The water user association in Dura has another branch of organization that is called "Equar" which sole purpose is to provide credit to the farmers based on their needs and their ability to pay for the credit according to the contract type. The credit will be given to farmers based on the purpose it will serve. If the farmer is discovered using the credit for another purpose than what it was borrowed for originally, the farmer will be warned following a lower credibility of the farmer for next loan.

Credit associations formed by the woreda is present at Laelay Logometi which offers loan for all the farmers in the area. This credit to farmers with payment based on the purpose credit granted for will last for a two years.

Dibdebo has Dedebit Microfinance and saving which offers credit services in the area when the farmers save a certain amount of money for a month in the institution. This credit to farmers with payment contract based on the purpose credit will last from two up to five years.

Even if access to credit was one of the explanatory variables in the model it has to be dropped because every farmer has access to credit

3.3.4 Major crops and vegetables produced on irrigation land

The major crops, vegetables and fruits produced by the selected irrigation farmers in Dura are listed in the table below

Table 3.3.4.1 Major crops and vegetables produced in Dura irrigation farm

Crops produced	Percentage
Onion	32.67%
Tomato	23.33%
Pepper	19.33%
Maize	10.67%
Cabbage	4.67%
Garlic	3.33%
Beet root	2.67%
Potato	1.33%
Carrot	0.67%
Fruit	0.67%

Teff	0.67%

Source: Survey 2016

The major crops, vegetables and fruits produced by the selected irrigation farmers in Laelay Logometi is listed in the table below.

Table 3.3.4.2 Major crops and vegetables produced in Laelay Logometi irrigation farm

Crops produced	Percentage
Maize	65.18%
Onion	33.93%
Fruit	0.89%

Source: Survey 2016

The major crops, vegetables and fruits produced by the selected irrigation farmers in Dibdebo is listed in the table below.

Table 3.3.4.3 Major crops and vegetables produced in Dibdebo irrigation farm

Crops produced	Percentage
Chickpea	71.76%
Fruit	8.24%
Onion	7.06%
Maize	4.71%
Garlic	3.53%
Pepper	2.35%
Cabbage	1.18%
Tomato	1.18

Source: Survey 2016

3.4 Empirical methods of data analysis

Cross sectional data was collected by using multistage sampling, where in the first stage the scheme members and non-members were separated. Followed by second stage where stratified random sampling was used to select 240 observations within the irrigation scheme taking into account their position of block (head, mid, tail). Econometric techniques of multivariate probit regression is used to assess the probability of participation of farmers in collective action for irrigation water management. Followed by Heckman sample selection to measure intensity of

participation in irrigation water management for those who have participated in the multivariate probit model.

Participation in collective action for irrigation scheme was measured by labour allocated towards main canal cleaning, contribution of funds for irrigation activities, participation in water related meetings.

Intensity of participation measures the level of involvement or how actively a farmer is participating in collective action. The person day labour spent on canal cleaning, the amount of money contributed irrigation activities and how many meetings attend per year will be used as a predicate variable to measure intensity.

The specification of a multivariate probit model is as follows

This multivariate probit model calculates the probability that farmers participate or don't participate given the dependent variables. It is an extension of the seemingly unrelated regression with binary dependent variables following a multivariate normal distribution using Geweke–Hajivassiliou–Keane recursive simulator (Gates, 2006) .The responsive variables $(Y_{im})^* = X_{im}\,\beta'_m + \varepsilon_{im}$ where $Y_{im} = 1$ if farmer participates in collective action and 0 if not where m=1,……, M with error that are correlated among systems of equations (Green, 2012)

Where the independent variables for this model are

$X_{m,1}$= constant,

$X_{h,2}$= Dummy variable for Gender of household head, where male= 1 and female= 0

$X_{h,3}$= Age of household head in years

$X_{h,4}$= Household labour supply for irrigation activities: no of members between the age of 15-64

$X_{h,5}$= No of years spent on education by the household head

$X_{h,6}$= Annual income of the household from irrigation in birr

$X_{h,7}$= whether household owns a mobile phone, where yes= 1 and no= 0

$X_{h,8}$= Whether household owns a radio, where yes= 1 and no= 0

$X_{h,9}$= Whether household owns a Television, where yes= 1 and no= 0

$X_{f,10}$= Size of irrigated farm in hectares (hectare)

$X_{f,11}$= Size of rain fed farm in hectares (hectare)

$X_{Inf,12}$= Distance to input market in walking minutes

$X_{Inf,13}$= Distance to all weather road in walking minutes

$X_{Inf,14}$= Distance to crop selling market in walking minutes

$X_{Ins,15}$= Extension contact in irrigation, where yes= 1 and no= 0

$X_{Ins,16}$= Extension contact in rained agriculture where yes= 1 and no= 0

$X_{Ins,17}$= Whether a household is a member of community based organizations, where yes= 1 and no= 0

$X_{s,18}$= Whether the rainfall is adequate for the irrigation farmer (his or her perception), where yes= 1 and no= 0

$X_{s,19}$= Age of irrigation dam

$X_{s,20}$= Dummy variable for position of block, where mid is used as a bench mark for head and tail

$X_{h,2}$ to $X_{h,9}$ are household level variables, $X_{f,10}$ and $X_{f,11}$ are farm level variables, $X_{inf,12}$ to $X_{inf,14}$ are infrastructure level variables, , $X_{ins,15}$ to $X_{ins,17}$ are institutional level variables , $X_{s,18}$ and $X_{s,20}$ are Scheme level variable

3.4.1 Hypothesis

3.4.1.1 Household level variables

Dummy variable for gender of household head, where male= 1 and female= 0 is determined by the model because it is determined by the social characteristics of the area (Deribe, 2008). ***Age of household head in years will*** have a sign that is determined by the model which can push the household to participate and not participate. Participate because they have more experience in farming and have better social ties than younger household heads. On the other hand, due to peer pressure and expectation of higher cooperation among their elders for an acceptance of their role as a household head in the village by younger household heads will participate (Muchara, et al., 2014).***Household family labour supply*** will have a positive relationship because it increases their productivity and reduce their cost. (Deribe, 2008) and (Muchara, et al., 2014).***Number of years spent on education by the household head*** will have a positive effect because as the number of years in education increases the household would be more likely to participate in collective action. (Deribe, 2008) and (Muchara, et al.,

2014). ***Annual income of household from irrigation in birr*** will be determined by the model because if agriculture is the main source of livelihood it would make it more likely to participate but if they have other source of income it will not be likely (Muchara, et al., 2014).***Whether household owns a mobile phone,*** where yes= 1 and no= 0 if a household owns a mobile phone it has a positive effect because this will reduce the cost of communication for collective action and will make farmers more alert in participation (Qaim & Fischer, 2012). ***Whether household owns Radio,*** where yes= 1 and no= 0 this determined by the model because of use on individuals purpose if a household uses his radio to obtain information it will have a positive effect on participation in collective action but for entertainment purpose it will be negative. ***Whether household owns Television,*** where yes= 1 and no= 0 the same proposition goes for ownership of television as outlined above for ownership of radio.

3.4.1.2 Farm level variables

Size of irrigation farm in hectare (timad) can be a proxy for wealth (Araral, 2009). This variable is expected to have a positive impact because farmers will be participating since they want to ensure their share of water is distributed to them without any cutbacks. ***Size of rained farm in hectares (Timad)*** is a variable that is expected to affect the probability of participation negatively making a farmer less likely in participation of collective action for irrigation activities.

3.4.1.3 Infrastructure level variables

Distance to input market in walking minutes is going to be determined by the model on how it affects the response variable. ***Distance to all weather road*** how this variable is going to affect the response variable will be determined by the model. ***Distance to crop selling market*** will affect the response variable positively as they are nearer to the market (Araral, 2009) and (Deribe, 2008).

3.4.1.4 Institutional level variables

Extension contact in irrigation will affect the probability of participation and will be determined by the model. ***Extension contact in rainfed agriculture*** will affect the probability of participation and will be determined by the model. ***Whether a***

household is a member in community based organizations, where yes= 1 and no= 0, will have a positive effect because it can enhance social norms and characters of how the farmers operate based on their community improving collective action (Deribe, 2008).

3.4.1.5 Scheme level variables

Whether the rainfall is adequate for the irrigation farmer (his or her perception), where yes= 1 and no= 0 will be determined by the model. (Deribe, 2008). ***Age of irrigation dam*** will have a positive effect because the higher age of the dam the more developed and organized farmers will be to participate in collective action. ***Dummy variable for position of block,*** where Head and tail are included in the model where mid is a benchmark how this variable affects independent variable is going to be determined by the model (Muchara, et al., 2014).

3.5 Econometric analysis

Following a Multivariate probit regression on did you clean dams in 2007, did you contribute funds for irrigation activities and attending meetings by water user association, Stata 13 was used to analyze every participation variable where participation was 1 and non-participation was 0 in the first stage. In the second stage using Heckman two stage sample selection model was used to check for existing of selection bias and to measure intensity of participation if there is selection bias. Adjusted model by Heckman was used to measure intensity of participation where the dependent variables for measuring intensity are how many person days a farmer cleaned the dam, how much fund a farmer contributed for irrigation activities and how many WUA yearly meetings were attended by the irrigation farmer.

3.5.1 Why Multivariate probit model?

Participation in collective action is a combination of factors that are considered as dependent variables in this study. This dependant variables are individual decisions made by irrigation farmers with relationship among one another. A decision to contribute funds for irrigation maintenance activities is interrelated with decision to clean dam. Interdependency of decision in participating in one activity and not participating in the other is at hand due to rational behaviour among participants. The

value given to personal gain is inconceivable compared to social welfare. Hence farmer's participation behave to maximize personal gain. (Muchara, et al., 2014).

A user written Stata command mvprobit by (Cappellari & Jenkins, 2003) was used. This command is multivariate probit model that follows the structure of a simulated maximum likelihood estimation using a GHK recursive conditional simulator developed by (Cappellari & Jenkins, 2003). When the number of random draws tends to infinity the more equivalent the simulated maximum likelihood will be to maximum likelihood estimation. The number of draws were increased to 15 than the default 5 (ibid).

Table 3.5.1 Results of the Multivariate probit model for cleaning of dams

Dam cleaning in 2007	Coefficients	Robust Standard error	P value
Own mobile phone	-.0196551	.278647	0.944
Own radio	-.2435572	.3392991	0.473
Own Television	-.2921425	.3686069	0.428
Age of Household head	.0091348	.009604	0.342
Education of household head	.0523275	.0457438	0.253
Labour force in the household	.2721043	.1018582	0.008***
Distance to all weather road	.0116634	.0056932	0.040**
Size of irrigation farm	-.6323973	1.925461	0.743
Size rainfed farm	.99506	1.576252	0.528
Income from irrigation	.0005847	.0002144	0.006**
Membership in community organization	.5788312	.2792184	0.038**
Distance to input market	-.0020036	.0064803	0.757
Distance to selling market	.0007345	.0027054	0.786
Household head Sex	-.2902285	.3073629	0.345
Extension contact in rainfed farming	.3064853	.5960536	0.607
Extension contact in irrigation farming	.1931537	.5793612	0.739
Head ender dummy	.7497844	.3593449	0.037**
Mid ender dummy	.5670992	.3960845	0.152
Age of Dam	.059651	.0339268	0.079*
Perception of rainfall adequacy	.7680998	.3238237	0.018**
Constant	-2.774607	.9132067	0.002**

Number of observation's= 239 Prob > chi2 = 0.0000
***1% significant Wald chi2(58) = 209.93
**5% significant

*10% significant
Source: Survey 2016

3.5.1.1 Results of determinants in collective action for cleaning of dam

The decision to participation in cleaning of dams was found to be significantly affected by labour force of the household, income earned from irrigation, distance to all weather road, membership in community organization, head ender dummy, age of dam, perception of rainfall adequacy out of 20 independent variables.

Labour force: - The more labour force available in a household the higher the predicted probability of participating in cleaning of dam. This shows the more the labour force the higher the labour presented to clean dam. Labour force was found to be statistically significant ($P<0.01$).

Distance to all weather road: - This has a positive effect on predicated probability of participation in cleaning of dam being statically significant ($P<0.05$). The longer a respondent takes to reach all weather road the higher the probability of participation was a surprising result.

Income earned from irrigation: - This has a positive effect on predicated probability participation in cleaning of dam. This shows a respondent earning more income from irrigation will have a higher probability of cleaning with significance level ($P<0.01$). Income earned from irrigation was determined by the model in the hypothesis which affects participation positively hence 94.2% of the respondents had crop farming as their main occupation.

Membership in community organization: - This has a positive effect on predicated probability participation in cleaning of dam with significance level ($P<0.05$). Membership in community based organization promotes social capital which is a vital element in participation. A respondent who is a member of community organization has a more probability of participating in cleaning of dam.

Head ender dummy: - This has a positive effect with significance level ($P<0.05$). Head ender farmer significantly has a higher probability of participation in cleaning of dam than tail ender farmers. Because the closer a farmer is the less the cost of travel to clean the dam.

Age of Dam: - This has a positive effect on predicated probability of participation in cleaning of dam with significance level ($P<0.1$). The higher age of dam shows more

organized and developed the local water user association. The older the dam is the higher the probability of farmer cleaning the dam.

Perception of rainfall adequacy: - This has a positive effect with significance level ($P<0.05$). If a respondent perceive rainfall is adequate, the more water available for rainfed farm hence to have a higher production of crops on irrigation farm the same respondent will have higher predicted probability of participation in cleaning.

Table 3.5.1.2 Results of the Multivariate probit model for contribution of funds

Contribution of fund in 2007	Coefficients	Robust Standard error	P value
Own mobile phone	.3641792	.2928257	0.214
Own radio	-1.03722	.336871	0.002***
Own Television	-1.179999	.3744703	0.002***
Age of Household head	.0278259	.0102905	0.007***
Education of household head	.1025706	.051549	0.047**
Labour force in the household	.2691476	.0914337	0.003***
Distance to all weather road	.0694708	.0159944	0.000***
Size of irrigation farm	5.188326	2.427177	0.033**
Size rainfed farm	-6.156575	1.526983	0.000***
Income from irrigation	.0001949	.0000998	0.051**
Membership in community organization	.9812963	.2932474	0.000***
Distance to input market	-.006127	.0070674	0.386
Distance to selling market	-.0002214	.0020065	0.912
Household head Sex	.069757	.2836954	0.806
Extension contact in rainfed farming	.695014	.3815502	0.069*
Extension contact in irrigation farming	-.1774156	.3861917	0.646
Head ender dummy	-.5545486	.3629627	0.127
Mid ender dummy	-.7206409	.3747694	0.054*
Age of Dam	.2795042	.0602501	0.000***
Perception of rainfall adequacy	1.359854	.4146796	0.001***
Constant	-6.356494	1.444584	0.000***

Number of observation's= 239 Prob > chi2 = 0.0000
***1% significant Wald chi2(58) = 209.93
**5% significant
*10% significant
Source: Survey 2016

3.5.1.2 Results of determinants in collective action for contribution of fund

The decision to contribute funds for irrigation activities was found to be significantly affected by 14 variables out of 20 explanatory variables.

Ownership of radio: - This has a negative effect with significance level ($P<0.01$), ownership of radio will decrease the probability of a farmer in contributing funds for irrigation activities. This is due to only 17% of the farmers have radio reverse results than originally excepted.

Ownership of television: - This had unforeseen results affecting contribution negatively with significance level ($P<0.01$), ownership of television will decrease the probability of a farmer in contributing funds for irrigation activities. This could be as a result of low ownership of television would reduce access to information and knowledge. 11.67% ownership, television in the sample having an adverse effect than expected.

Age of household head: - This has a positive effect with significance level ($P<0.01$). The older a household head is the higher the probability of contribution of funds to irrigation activities. Older household head will have more experience in irrigation farming and better social ties

Education of household head: - This has a positive effect with significance level ($P<0.05$). The more educated house hold head is the higher the probability of contribution of funds to irrigation activities. Household head education is essential to comprehend various maintenance costs are required.

Labour force of the household: - This has a positive effect with a significance level ($P<0.01$). The higher the Labour force the higher predicated probability of contribution of funds in irrigation activities. The more the Labour force the higher the earning capacity of the household.

Distance to all weather road: - This has a positive effect with a significance level ($P<0.01$).

The longer a farmer has to travel to reach all weather road the higher predicated probability of contribution of funds in irrigation activities. The collective effect of being a remote area demands more transportation cost to replace irrigation facilities. The longer it takes to reach all weather road the more cost incurred on a farmer

implying households have to travel by foot using shortcuts to reach all weather road leaving fund for contribution to be higher.

Membership in community organization: - This has a positive effect with a significance level (P<0.01).Being a member of community organization will increase the probability of contribution of funds significantly as a result of social ties imposing indirect reminder and ability to be better household in the community.

Size of irrigation farm: - This has a positive effect with a significance level (P<0.05). The higher the size of irrigation farm, the more predicted probability of contribution funds. Due to the higher the size of land the more a household is required and able to contribute funds.

Income earned from irrigation: - This has a positive effect with significant level (P<0.05). The higher the income, the more the predicted probability of fund contribution. The more income earned from irrigation farming the more time spent working on it.

Size of rainfed farm: - This has a negative effect with significant level(P<0.01).The amount of time spent on irrigation farm and rainfed farm depends on its size if a household has larger rainfed farm the higher the amount of time spent on working on the farm will lead to lower contribution of funds for irrigation farm.

Extension contact in rainfed farming: - This has a positive effect with significance level (P<0.1). Farmers who take rainfed agriculture training will have a higher predicted probability of contribution of funds. Rainfed agriculture training is similar to irrigation trainings improving yield hence more fund available

Mid ender dummy: - This has a negative effect with significance level (P<0.1). Mid ender farmer significantly has a lower probability of contributing of funds for irrigation activities than tail ender farmers. The geographical advantage a mid-ender has will give it closer access but tail enders had to contribute funds for stable water flow.

Age of dam: - This has a positive effect with significance level (P<0.01). Age of dam shows the strength and the development of irrigation scheme beneficiaries as the years go by affecting contribution positively.

Perception of rainfall adequacy: - This has a positive effect with significance level (P<0.01). If a respondent perceive rainfall is adequacy the more water available for rainfed farm hence to have a higher production of crops on irrigation farm the same respondent will contribute more fund.

Table 3.5.1.3 Results of the Multivariate probit model for Attending of meetings

Attendance of meetings by WUA in 2007	Coefficients	Robust Standard error	P value
Own mobile phone	.1586323	.2821909	0.574
Own radio	-.0569252	.3525448	0.872
Own Television	-.836876	.3765436	0.026**
Age of Household head	.0015332	.0093239	0.869
Education of household head	-.0139591	.0426344	0.743
Labour force in the household	.2752562	.1068896	0.010**
Distance to all weather road	.0219612	.0075419	0.004***
Size of irrigation farm	.2910206	1.790039	0.871
Size rainfed farm	.9795684	1.473011	0.506
Income from irrigation	.0001397	.0000761	0.066 *
Membership in community organization	.5304036	.3162167	0.093*
Distance to input market	.0161603	.0133286	0.225
Distance to selling market	-.0018865	.0022764	0.407
Household head Sex	-.0861668	.351788	0.807
Head ender dummy	-.2266441	.3500804	0.517
Mid ender dummy	-.4550953	.3609438	0.207
Age of Dam	.1657288	.0436386	0.000***
Perception of rainfall adequacy	.6439849	.3319098	0.052*
Constant	-2.416803	.9697454	0.013**
/atrho21	1.030145	.3487111	0.003***
/atrho31	1.100745	.4139921	0.008***
/atrho32	1.403662	.2883021	0.000***
rho21	.7739664	.1398248	0.000***
rho31	.8007666	.1485291	0.000***
rho32	.8861406	.0619143	0.000***

Number of observation's= 239 Prob > chi2 = 0.0000
***1% significant Wald chi2(58) = 209.93
**5% significant
*10% significant
Source: Survey 2016

The multivariate model of participation for collective action can be acceptable because the error correlation (rho_{ij}) and the covariance matrix ($/atrho_{ij}$) are significant. The decision to participation in cleaning of dams was found to be significantly affected by labour force of the household, income earned from irrigation, membership in community organization out of 20 independent variables.

3.5.1.3 Results of determinants in collective action for attending meetings

The Decision to attend water related meetings held by water user association is significantly affected by ownership of television, labour force of household, distance to all weather road, income from irrigation, membership in community organization, age of dam and perception of rainfall adequacy. Out of the 20 explanatory variables extension contact in irrigation farming and rainfed farming were dropped out because they perfectly predict attendance in meeting. Household are organized in farmers training centres to attend meetings held by water user association as well as extension training programs.

Ownership of television: - This has a positive effect with significance level ($P<0.05$). This can be explained by the same logic as explained above on how it affects attendance of meetings negatively.

Labour force of the household: - Labour force has a positive effect with significance level ($P<0.05$). The higher the labour force, the higher the predicted probability of attending a meeting because household can be represented on his/her behalf on meetings by family members when he/she can't make it.

Distance to all weather road: - This has a positive effect with significance level ($P<0.01$). The longer it take to reach all weather road the higher the predicted probability of attending meetings. A farmer who is in remote area would attend meetings more regularly, with fear of repercussion from decided conclusions of meetings which would be higher on him/her.

Income from irrigation: - This has a positive effect with significance level ($P<0.01$). Households earning more income from irrigation would have to participate in meetings to discuss on all issues that would affect their irrigation farm.

Membership in community organization: - This has a positive effect with significance level ($P<0.1$).Being a member of community organization will increase the predicted probability of attending meetings. Membership in community organization creates social ties among farmers.

Age of dam: - This has a positive effect with significance level ($P<0.01$). As Age of dam increase farmer will have higher predicted probability of attending meetings. The older the age of dam affects more farmers are more trained and organized from their experiences.

Ownership of radio and television doesn't only show access to information but also can be a sign of wealth. Hence a farmer likelihood of participation in attending meetings is be affected by ownership of television. Also a farmer likelihood of participation in contribution of funds is be affected by both ownership of television and radio.

3.5.2 Heckman sample selection model

To analyze the individual intensity of participation, econometric model specifically regression model with sample selection was used. Given that the household participates in water management activities. We can measure their intensities.

Running a seemingly unrelated regression as a second stage would have been acceptable if the respondents that participated in collective action were selected at random but respondents are self-selected non-randomly. Non random selection leads to incidental truncation of sample hence sample selection bias occurs. Heckman sample selection model was implemented to correct for sample selection (Heckman, 1979).

This probit model calculates the probability that farmers participate or don't participate with the responsive variable y_i

$y_i^* = x_i'\gamma + \varepsilon_i$, $y_i = 1$ if $y_i^* > 0$

$\text{Prob}(y_i = 1 \mid x_i) = \Phi(x_i\gamma)$ where $y_i = 1$ if farmer participates in collective action and 0 if not, x_i is a vector of independent variables, γ is a vector of unknown variables and Φ is cumulative distribution function. (Green, 2012) Estimation of the model will produce results that can be used to predict participation probability of each farmer.

In the second stage self-selection for those who participated has to be corrected. The intensity equation may be specified as follows

$I^* = X\beta' + u_i$

Where I* symbolizes intensity of participation, which can't be observed if the farmer doesn't participate. The conditional expectation of intensity given the farmer participates is

$E [I|X, y_i=1] = X\beta + E [ui|X, y_i=1]$

Based on the assumption that error terms $(\varepsilon_i\ u_i) \sim$ jointly normal $[0, 0, 1, \sigma_u, \rho]$ it follows

$E [I|X, y_i=1] = X\beta+\rho\sigma_u\lambda(x_i\gamma)$

Where ρ is the correlation between unobserved determinants of tendency to participate in collective action, σ_u is the standard deviation of ui and λ is the inverse Mill's ratio evaluated at $x_i\gamma$. Inverse Mill's is a ratio of probability density function over the cumulative density function The above illustration shows that sample selection is considered as omission of variable bias where $(u_i \mid \varepsilon_i > -x_i\gamma)$ is the omitted variable. An estimate of the omitted variable would solve the sample selection bias.

After running Heckman sample selection on three univariate probit regression models for each dependant variable outlined on the multivariate probit model. It was found out that Inverse mills ratio was significant for cleaning of dams and attending meetings showing selection bias is serious problem, while it was found to be insignificant for contribution of funds. Following multivariate probit model Heckman sample selection would be applied on each dependant variables that explains intensity of participation in collective action. Heckman was applied on how many days cleaned, how much funds contributed and how many days attended.

3.5.2.1 Results of intensity of participation for how many person day cleaned

Ownership of mobile phone: - This has a positive effect with significance level ($P<0.05$). This shows a respondent having participated in cleaning of dams will be more intensive with ownership of mobile phone. Mobile phone is a source of information with two direction communication enabling an owner to obtain as much information as needed. For ownership of mobile phone by a farmer he/she would spend 3.3 person days more in cleaning of dams.

Ownership of radio: - This has a negative effect with significance level ($P<0.1$). A respondent ownership of radio is not only for the purpose of information but also entertainment. As shown in the descriptive analysis low ownership among respondents

will have the reverse effect than expected. Farmer who owns a radio would decrease 2.18 person days of cleaning than who doesn't

Age of household head: - This has a positive effect with significance level (P<0.05). As a household head is older the more experience attained will increase person days spent cleaning irrigation dam. As the age of household head increases he/she would clean 0.08 days more than younger household.

Education of household head: - This has a positive effect with significance level (P<0.1).the more educated a household head is the higher the person days spent on cleaning the dam. This is straight forward explanation. The higher the grade of class attended by a household head, he/she would clean 0.29 more days than the lower grade attended household.

Size of irrigation farm: - This has a negative effect with significance level (P<0.01). A farmer would be less intensive in cleaning irrigation dam as the higher the size of irrigation farm owned. The higher the size of irrigation farm the more he/she has to work on it leaving person days for cleaning limited. The higher the hectare of irrigation farm, farmers person day cleaned will reduce by 27.

Age of dam: - This has a positive effect with significance level (P<0.01). A farmer will be more experienced and trained with higher age of dam explaining the positive relationship observed. The older the dam 0.6 more days spent cleaning by farmer.

Perception of rainfall adequacy: - This has a negative effect with significance level (P<0.05). If a farmer perceives the rainfall is adequate the more water available reducing intensity in cleaning of dam. If a farmer perceives rainfall will be adequate he/she would have 2 less person days spent on cleaning.

Lambda: - This has a positive effect with significant level (P<0.01). Lambda shows there is a problem selection bias that can't be ignored. The positive sign shows there are unobserved factors affecting how many person days a farmer cleaned positively.

The mean VIF (variance inflation factor) for this model is 1.94 showing very low correlation.

Table 3.5.2.1 Heckman model for how many days cleaned (regression model with sample selection)

How many days cleaned in 2007?	Coefficients	Standard error	P value	VIF
Own mobile phone^	3.375633	1.057505	0.001***	1.65
Own radio^	-2.183491	1.185452	0.065*	1.22
Own Television^	-.3473404	1.556219	0.823	1.30
Age of Household head	.081632	.0366166	0.026**	1.44
Education of household head	.2941174	.1686386	0.081*	1.68
Labour force in the household	.0090494	.3078054	0.977	1.53
Distance to all weather road	-.0220815	.0160792	0.170	1.98
Size of irrigation farm	-27.28479	7.944676	0.001***	3.16
Size rainfed farm	1.903711	6.001851	0.751	2.21
Income from irrigation	.0000743	.0001005	0.460	1.50
Distance to input market	-.0009512	.0288267	0.974	1.23
Distance to selling market	-.0084299	.008627	0.328	1.94
Household head Sex^	-1.283588	1.066363	0.229	1.34
Extension contact in rainfed farming^	-1.765055	1.544218	0.253	3.15
Extension contact in irrigation farming^	-2.192774	1.547416	0.156	3.22
Head ender dummy^	.4494068	1.24977	0.719	2.17
Mid ender dummy^	-1.951489	1.215658	0.108	1.85
Age of Dam	.6030801	.1019723	0.000***	2.68
Perception of rainfall adequacy^	-2.248748	1.047702	0.032**	1.60
Lambda	3.759433	2.00891	0.061*	2.01
Constant	2.593317	3.399829	0.446	

Number of observation = 239 Censored observation = 38
Uncensored observation = 201 Prob > chi2 =0.0000 Wald chi2(19) =199.32
***1% significant (^) shows dummy variables
**5% significant
*10% significant
Source: Survey 2016

3.5.2.2 Results of intensity of participation for how much money contributed

Ownership of mobile phone: - This has a negative effect with significance level (P<0.05). Ownership of mobile phone would decrease the fund contributed for irrigation activities by a household with ownership of mobile phone comes a variable cost. A farmer who owns mobile phone would contribute 7 ETB less than a farmer who doesn't

Distance to all weather road: - This has a positive effect with significance level (P<0.1). The longer it take to reach all weather road the higher the contribution of funds by a famer. Each farmer would have to share the cost of irrigation facilities. A famer who travels more to reach all weather road would contribute 8 cents more than a farmer closer to all weather road.

Size of irrigation farm: - This has a positive effect with significance level (P<0.01). The higher the size of irrigation farm the more amount contributed. Farmer with larger irrigation farm would have to contribute more money to finance the cost of irrigation facilities. The more water a farmer uses the higher he/she has to contribute. A farmer who has a larger irrigation farm would contribute 60 ETB more than with smaller irrigation farm.

Distance to crop selling market: - This has a positive effect with significance level (P<0.05). The longer it takes a farmer to reach crop selling market the more amount of money contributed to irrigation activities. Since farming is the main source income for a farmer a problem with water distribution with the dam would significantly reduce his/her income. A farmer would set aside the amount needed to contribute and travel by foot to crop selling market. A farmer who has to travel more to reach crop selling market would contribute 5 cents than closer farmer.

Extension contact in irrigation farming: - This has a positive effect with significant level (P<0.01). The more irrigation practices training will increase the know-how of farmers with understanding of the various cost incurred a farmer will contribute more money. A farmer who attended irrigation trainings would contribute 11 ETB more than farmer who didn't attend.

Household Head Sex: - This has a positive effect with significant level (P<0.1). Male headed households would contribute more money than female headed households this is because 52% of the female household heads are over the age of 50 and 47% divorced showing very low income for female headed households. A male household head would contribute 5 ETB than a female household head.

Head ender dummy: - This has a negative effect with significant level (P<0.05). Tail ender farmers would contribute significantly more money than head ender farmers. Tail ender farmers are the main fatalities if water flow reduces. A tail ender farmer would contribute 7.4 ETB than a head end farmer.

Mid ender dummy: - This has a negative effect with significant level (P<0.01). Tail ender farmers would contribute significantly more money than mid ender farmers. Based on the same logic will be the same given for head ender dummy above. A tail end farmer would contribute 9 ETB more than a mid end farmer

Age of dam: - This has a positive effect with significance level (P<0.01). The older the dam the more renovation required to keep flow of water along the farmer's stable demanding higher contribution of money by the farmers. The older the age of dam 2ETB more is contributed by farmers for renovation

Perception of rainfall adequacy: - This has a positive effect with significance level (P<0.01).Positive perception of rainfall adequacy will increase the contribution of money for irrigation activities. Hence rainfall is an important source of water for irrigation if a farmer has positive perception he will contribute more money to facilitate proper water distribution. Proper water distribution will reduce the possibility of mismatch between timing of water allocation. If a farmer perceives rainfall is adequate he/she would contribute 12.6 ETB for irrigation activities.

The mean VIF (variance inflation factor) for this model is 1.91 showing very low correlation.

Table 3.5.2.2 Heckman model for how much funds contributed (regression model with sample selection)

How much funds contributed in 2007?	Coefficients	Standard error	P value	VIF
Own mobile phone	-7.040193	2.876986	0.014***	1.58
Own radio	.8016917	3.363356	0.812	1.18
Own Television	-5.820649	4.538732	0.200	1.41
Age of Household head	-.0249297	.0994967	0.802	1.42
Education of household head	-.3898859	.4701507	0.407	1.71
Labour force in the household	.4623886	.8359677	0.580	1.49
Distance to all weather road	.0886426	.0463931	0.056*	2.16
Size of irrigation farm	60.20232	17.61929	0.001***	2.51
Size rainfed farm	11.37236	17.58442	0.518	2.26
Income from irrigation	-.0001236	.00028	0.659	1.52
Distance to input market	-.0555915	.0886282	0.530	1.22
Distance to selling market	.0561572	.0235231	0.017**	1.94
Household head Sex	4.948673	2.929289	0.091*	1.31
Extension contact in rainfed farming	5.50774	4.266128	0.197	3.10

Extension contact in irrigation farming	11.10332	4.188984	0.008***	3.03
Head ender dummy	-7.452146	3.238671	0.021**	1.92
Mid ender dummy	-9.128276	3.262249	0.005***	1.68
Age of Dam	2.135239	.2980153	0.000***	3.01
Perception of rainfall adequacy	12.65465	2.864624	0.000***	1.56
Lambda	-5.776468	6.625773	0.383	2.21
Constant	-16.27861	9.33328	0.081*	

Number of observation = 240 Censored observation = 35
Uncensored observation = 205 Prob > chi2 =0.0000 Walchi2(19)=364.54
***1% significant
**5% significant
*10% significant
Source: Survey 2016

3.5.2.3 Results of intensity of participation for how many meetings attended

Size of irrigation farm: - This has a positive effect with significance level (P<0.01). The higher the size of irrigation farm the more household would be attending meetings. Large size of irrigation farm affects income earned making farmer attended meetings as much as possible. The larger the size of an irrigation farm a famer, would participate on 11 more meetings

Distance to input market: - This has a positive effect with significance level (P<0.05).The longer it takes the farmer to reach input market the more regular a farmer would attend meetings. The further an input market is the more cost spent traveling. The more attentive a farmer is in meetings the more problems will be solved in collective action. The better the local water user association the more income earned by farmers. If a farmer is further from input market the farmer will be more likely to attend 1 meeting per year.

Distance to crop selling market: - This has a positive effect with significance level (P<0.05). The longer it takes a famer to reach crop selling market the higher attendance in meetings. Following the same logic outlined above farmers would attend more meetings the longer it takes them to reach crop selling market. If a farmer is further from crop selling market the farmer will be more likely to attend at most 1 meeting per year.

Mid ender dummy: - This has a positive effect with significant level (P<0.05). Mid ender farmers would significantly attend meetings more than tail ender farmers. This is unexpected result.

Age of dam: - This has a positive effect with significant level (P<0.01). The older the age of irrigation dam the more farmers attends meetings. The older the irrigation dam the stronger the local water user association. The older the dam a farmer would participate 5 meetings per year

Lambda: - This has a negative effect with significant level (P<0.05). Lambda is statically significant implying there is selection bias in the model. The negative sign shows there are unobserved variables that affect attending of meetings negatively.

The mean VIF (variance inflation factor) for this model is 1.91 showing very low correlation.

Table 3.5.2.3 The Heckman model for how many meetings attended (regression model with sample selection)

How many meetings attended in 2007?	Coefficients	Standard error	P value	VIF
Own mobile phone	-.8894139	.5474299	0.104	1.60
Own radio	-.852685	.6214332	0.170	1.17
Own Television	-.3260779	.8279213	0.694	1.41
Age of Household head	.0077842	.0189795	0.682	1.43
Education of household head	.1179998	.0876036	0.178	1.60
Labour force in the household	.1117922	.1755006	0.524	1.72
Distance to all weather road	.0064682	.0096747	0.504	2.47
Size of irrigation farm	11.9711	4.003565	0.003***	3.01
Size rainfed farm	-5.271587	3.253133	0.105	2.28
Income from irrigation	.0000153	.0000569	0.788	1.55
Distance to input market	.030597	.0154223	0.047**	1.20
Distance to selling market	.0104477	.0046594	0.025**	2.06
Household head Sex	.6630517	.5677403	0.234	1.40
Head ender dummy	-.7011374	.6101298	0.250	1.85
Mid ender dummy	1.345744	.6114175	0.028**	1.61
Age of Dam	.2293629	.0644235	0.000***	3.67
Perception of rainfall adequacy	.4141074	.544594	0.447	1.51
Lambda	-3.282997	1.6991	0.053**	2.76
Constant	1.974677	1.930123	0.306	

Number of observation = 239 Censored observation = 25
Uncensored observation = 214 Prob > chi2 =0.0000 Wald chi2(17) =114.16
***1% significant
**5% significant
*10% significant
Source: Survey 2016

Chapter 4 Conclusion and Recommendation

4.1 Conclusion

For a rainfed dependant farming patterns with rudimentary tools, irrigation is the better option to improve productivity and livelihood. Small scale irrigation farming is practiced in Ethiopia on large scale providing farmers higher income than before. Dam irrigation projects are growing with small scale farming demanding local administration or local water user association to improve and maintain collective action among farmers.

What is collective action in irrigation water management? What determines farmers participation in collective action in irrigation water management? After a farmer participates in collective action what are the factors that affect intensity of participation? All of the above questions have been addressed in this study.

Collective action is a combination of many activities that improve conditions of water management across farmers. These activities definition differs according to locations and schemes In this study collective action is represented by three variables, Cleaning of Dam, Contribution of funds for irrigation activities and attending meetings issued by local water user associations.

The importance of institutions was obtained from the results. Specifically informal institutions affect collective action participation highly compared to formal institutions. Farmers membership in community based organization represent informal institutions which affected collective action positively. Membership in community based organization can also show social ties among farmers. Hence even if more work is done to promote formal institutions to encourage collective action more push should be given to informal institutions. Working on social ties from informal institutions that portray social ties is possible in the specific case with promotion of farmers to have membership in community based organizations

It was found out the labour force available in a house hold, Distance to all weather road, Income earned from irrigation farming, membership in community organization, Age of dam and perception of rainfall adequacy affect all the three dependant variable positively. Distance to all weather road had an unexpected result showing the more a farmer has to travel to reach all weather road the more likely he/she participate in collective action. This results were given justification according to collective action participation measurement variable considered. Perception of rainfall adequacy affecting collective action positively was unexpected but it shows farmers work hard to ensure collective action in irrigation water management. This variables should be given emphasis hence the are the determinants of collective action

Participation in cleaning of dams was affected by labour force of household, distance to all weather road, income from irrigation farming, membership of community based organization, age of dam and perception of rainfall adequacy. Head ender farmer clean dams more than tail end farmers this could be due to tail ender farmers are further away from the dam and don't participate in this cleaning rather their participate in contribution of funds

Participation in contribution of funds was affected by age of household head, education of household head, labour force of the household, size of irrigation farm, size of rained farm, income from irrigation, membership is community based organization, extension contact in rainfed farming, age of dam, and perception of rainfall adequacy. Tail ender farmers contribute more funds than mid end farmers requiring attention to monitor contribution made by mid end farmers. Ownership of radio and ownership of television had an unanticipated results lowering likelihood of contribution if a farmer owns Television or radio. It shows farmers who own television and radio use it mainly for entertainment can be one explanation but this variables can also be a sign of wealth.

Attendance of meetings was affected by labour force of the household, income from irrigation, distance to all weather road, membership is community based organization, age of dam, and perception of rainfall adequacy. Any of the position of block variables were not found to be significant. Television is used for entertainment for farmers who own it reducing their attendance in meetings

Intensity of collective action given farmer participates in collective action measuring variables were affected by age of dam and size of irrigation farm. Age of dam affected all positively while size of irrigation farm had a different sign based on which activity. Once again we can find proof that the more years, experience the higher intensity of participation in collective action.

Spending more person days for cleaning dam was affected by ownership of mobile phone and radio, age of household head, education of household head, size of irrigation dam, age of dam, perception of rainfall adequacy. The majority of this variables are household level variables. Hence we can conclude intensity in participation cleaning is highly affected by each household level characters more so than institutions. This evidence may hold true for other specific cases. While the importance of age of dam should be highly acknowledged once internal institutions such as local water user association grow and improve on ensuring intensive participation in collective action.

How much money contributed for irrigation activities is affected by ownership of mobile phone, distance to all weather road, size of irrigation farm, distance to selling market, extension contact in irrigation farming, age of dam and perception of rainfall adequacy. Infrastructural level variables affects how much a farmer contributes more than household level variables and scheme level variables show more effect here than intensity spent for cleaning. Tail ender farmers (downstream farmers) were found to contribute more money than head and mid ender farmers (upstream farmers). Downstream farmers are more affected by infrastructural variables than upstream farmers.

Attendance of meetings by WUA is found to be affected by size of irrigation dam, distance to input market, distance to selling market and age of dam. Infrastructural level variables are also seen to affect attendance in meetings held by WUA. It is possible to conclude this variables are really important in affecting intensity more than participation in collective action.

Farmers irrigation farm position of block was expected to affect collective action measuring variables largely but it only affected participation in cleaning and contribution of funds.

In qualitative results it is clear that Dura was found to better site in practicing collective action than Dibdebo and Laelay Logometi. Dura irrigation dam is older than any of the others. Age of local water user association can be seen as an evidence for better collective action.

4.2 Recommendations

- It has been found that majority of farmers income is dependent on agricultural production. Irrigation is one component of agricultural production, improving livelihood of farmers. Construction of small scale irrigation schemes will improve the welfare of farmers.
- It has been found that membership in community organization significantly affects farmers collective action. Hence encouraging expansion of community organization would improve collective action.
- It has been found out no matter the distance to all weather road a farmer still participates in collective action because irrigation farming amounts to majority of his/her income. Constructing all weather road would further enhance farmer's willingness to participate in collective action.

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Annex

Multivariate model results for determinants of participation in collective action

```
. mvprobit (ddidu_clean = have_mobilephone have_radio have_TV age education ///
> laborforce distance_awr size_irrgation_farm size_rainfed_farm income_irrgation ///
> memb_communityorg distance_inputmarket distance_sellingmarket hhsex extension_rain ///
> extension_irrigation head_d mid_d age_of_dam perception_rainadeq)(Cont_fund = have_mobilephone ///
> have_radio have_TV age education laborforce distance_awr size_irrgation_farm ///
> size_rainfed_farm income_irrgation memb_communityorg distance_inputmarket ///
> distance_sellingmarket hhsex extension_rain extension_irrigation head_d mid_d age_of_dam ///
> perception_rainadeq)(dmeting_ind = have_mobilephone have_radio have_TV age education ///
> laborforce distance_awr size_irrgation_farm size_rainfed_farm income_irrgation ///
> memb_communityorg distance_inputmarket distance_sellingmarket hhsex head_d mid_d ///
> age_of_dam perception_rainadeq), robust draws (15)

Iteration 0:   log pseudolikelihood =  -173.4573
Iteration 1:   log pseudolikelihood = -152.03889
Iteration 2:   log pseudolikelihood = -145.94327
Iteration 3:   log pseudolikelihood = -144.86233
Iteration 4:   log pseudolikelihood = -144.79382
Iteration 5:   log pseudolikelihood = -144.79336
Iteration 6:   log pseudolikelihood = -144.79336

Multivariate probit (SML, # draws = 15)          Number of obs   =        240
                                                 Wald chi2(58)   =     209.93
Log pseudolikelihood = -144.79336                Prob > chi2     =     0.0000
```

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
ddidu_clean						
have_mobilephone	-.0196551	.278647	-0.07	0.944	-.5657932	.526483
have_radio	-.2435572	.3392991	-0.72	0.473	-.9085713	.4214569
have_TV	-.2921425	.3686069	-0.79	0.428	-1.014599	.4303136
age	.0091348	.009604	0.95	0.342	-.0096887	.0279583
education	.0523275	.0457438	1.14	0.253	-.0373286	.1419837
laborforce	.2721043	.1018582	2.67	0.008	.0724658	.4717427
distance_awr	.0116634	.0056932	2.05	0.040	.0005049	.0228218
size_irrgation_farm	-.6323973	1.925461	-0.33	0.743	-4.406232	3.141438
size_rainfed_farm	.99506	1.576252	0.63	0.528	-2.094338	4.084458
income_irrgation	.0005874	.0002144	2.74	0.006	.0001671	.0010076
memb_communityorg	.5788312	.2792184	2.07	0.038	.0315733	1.126089
distance_inputmarket	-.0020036	.0064803	-0.31	0.757	-.0147047	.0106975
distance_sellingmarket	.0007345	.0027054	0.27	0.786	-.004568	.006037
hhsex	-.2902285	.3073629	-0.94	0.345	-.8926487	.3121916
extension_rain	.3064853	.5960536	0.51	0.607	-.8617584	1.474729
extension_irrigation	.1931537	.5793612	0.33	0.739	-.9423733	1.328681
head_d	.7497844	.3593449	2.09	0.037	.0454812	1.454087
mid_d	.5670992	.3960845	1.43	0.152	-.2092122	1.34341
age_of_dam	.059651	.0339268	1.76	0.079	-.0068443	.1261464
perception_rainadeq	.7680998	.3238237	2.37	0.018	.133417	1.402783
_cons	-2.774607	.9132067	-3.04	0.002	-4.56446	-.984755

Cont_fund						
have_mobilephone	.3641792	.2928257	1.24	0.214	-.2097485	.938107
have_radio	-1.03722	.336871	-3.08	0.002	-1.697475	-.3769644
have_TV	-1.179999	.3744703	-3.15	0.002	-1.913948	-.4460512
age	.0278259	.0102905	2.70	0.007	.0076569	.0479949
education	.1025706	.051549	1.99	0.047	.0015364	.2036049
laborforce	.2691476	.0914337	2.94	0.003	.0899409	.4483544
distance_awr	.0694708	.0159944	4.34	0.000	.0381223	.1008192
size_irrgation_farm	5.188326	2.427177	2.14	0.033	.4311468	9.945505
size_rainfed_farm	-6.156575	1.526983	-4.03	0.000	-9.149406	-3.163743
income_irrgation	.0001949	.0000998	1.95	0.051	-6.90e-07	.0003905
memb_communityorg	.9812963	.2932474	3.35	0.001	.4065419	1.556051
distance_inputmarket	-.006127	.0070674	-0.87	0.386	-.0199789	.0077249
distance_sellingmarket	-.0002214	.0020065	-0.11	0.912	-.0041541	.0037113
hhsex	.069757	.2836954	0.25	0.806	-.4862759	.6257898
extension_rain	.695014	.3815502	1.82	0.069	-.0528106	1.442839
extension_irrigation	-.1774156	.3861917	-0.46	0.646	-.9343374	.5795062
head_d	-.5545486	.3629627	-1.53	0.127	-1.265943	.1568453
mid_d	-.7206409	.3747694	-1.92	0.054	-1.455176	.0138937
age_of_dam	.2795042	.0602501	4.64	0.000	.1614161	.3975922
perception_rainadeq	1.359854	.4146796	3.28	0.001	.5470969	2.172611
_cons	-6.356494	1.444584	-4.40	0.000	-9.187826	-3.525161
dmeting_ind						
have_mobilephone	.1586323	.2821909	0.56	0.574	-.3944517	.7117163
have_radio	-.0569252	.3525448	-0.16	0.872	-.7479003	.6340499
have_TV	-.836876	.3765436	-2.22	0.026	-1.574888	-.0988641
age	.0015332	.0093239	0.16	0.869	-.0167413	.0198077
education	-.0139591	.0426344	-0.33	0.743	-.097521	.0696028
laborforce	.2752562	.1068896	2.58	0.010	.0657564	.484756
distance_awr	.0219612	.0075419	2.91	0.004	.0071793	.036743
size_irrgation_farm	.2910206	1.790039	0.16	0.871	-3.217392	3.799433
size_rainfed_farm	.9795684	1.473011	0.67	0.506	-1.907481	3.866618
income_irrgation	.0001397	.0000761	1.84	0.066	-9.48e-06	.000289
memb_communityorg	.5304036	.3162167	1.68	0.093	-.0893698	1.150177
distance_inputmarket	.0161603	.0133286	1.21	0.225	-.0099633	.0422838
distance_sellingmarket	-.0018865	.0022764	-0.83	0.407	-.0063482	.0025753
hhsex	-.0861668	.351788	-0.24	0.807	-.7756586	.603325
head_d	-.2266441	.3500804	-0.65	0.517	-.912789	.4595008
mid_d	-.4550953	.3609438	-1.26	0.207	-1.162532	.2523416
age_of_dam	.1657288	.040396	4.10	0.000	.0865541	.2449034
perception_rainadeq	.6439849	.3319098	1.94	0.052	-.0065465	1.294516
_cons	-2.416803	.9697454	-2.49	0.013	-4.317469	-.5161367
/atrho21	1.030145	.3487111	2.95	0.003	.3466835	1.713606
/atrho31	1.100745	.4139921	2.66	0.008	.2893358	1.912155
/atrho32	1.403662	.2883021	4.87	0.000	.8386002	1.968723
rho21	.7739664	.1398248	5.54	0.000	.333431	.9370885
rho31	.8007666	.1485291	5.39	0.000	.2815233	.957266
rho32	.8861406	.0619143	14.31	0.000	.6850669	.9617499

Likelihood ratio test of rho21 = rho31 = rho32 = 0:
chi2(3) = 57.3279 Prob > chi2 = 0.0000

Heckman sample selection model for how many person days spent cleaning

```
. heckman how_many_pdc have_mobilephone have_radio have_TV age education ///
> laborforce distance_awr size_irrgation_farm size_rainfed_farm income_irrgation ///
> distance_inputmarket distance_sellingmarket hhsex extension_rain extension_irrigation ///
> head_d mid_d age_of_dam perception_rainadeq, select (ddidu_clean= have_mobilephone have_radio have_TV age education ///
> laborforce distance_awr size_irrgation_farm size_rainfed_farm income_irrgation ///
> memb_communityorg distance_inputmarket distance_sellingmarket hhsex extension_rain ///
> extension_irrigation head_d mid_d age_of_dam perception_rainadeq) twostep

Heckman selection model -- two-step estimates   Number of obs      =       239
(regression model with sample selection)        Censored obs      =        38
                                                Uncensored obs    =       201

                                                Wald chi2(19)     =    199.32
                                                Prob > chi2       =    0.0000
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
how_many_pdc						
have_mobilephone	3.375633	1.057505	3.19	0.001	1.302962	5.448305
have_radio	-2.183491	1.185452	-1.84	0.065	-4.506933	.1399514
have_TV	-.3473404	1.556219	-0.22	0.823	-3.397474	2.702793
age	.081632	.0366166	2.23	0.026	.0098649	.1533991
education	.2941174	.1686386	1.74	0.081	-.0364083	.624643
laborforce	.0090494	.3078054	0.03	0.977	-.5942381	.6123369
distance_awr	-.0220815	.0160792	-1.37	0.170	-.0535962	.0094333
size_irrgation_farm	-27.28479	7.944676	-3.43	0.001	-42.85607	-11.71351
size_rainfed_farm	1.903711	6.001851	0.32	0.751	-9.8597	13.66712
income_irrgation	.0000743	.0001005	0.74	0.460	-.0001227	.0002714
distance_inputmarket	-.0009512	.0288267	-0.03	0.974	-.0574506	.0555482
distance_sellingmarket	-.0084299	.008627	-0.98	0.328	-.0253385	.0084787
hhsex	-1.283588	1.066363	-1.20	0.229	-3.373621	.8064444
extension_rain	-1.765055	1.544218	-1.14	0.253	-4.791667	1.261557
extension_irrigation	-2.192774	1.547416	-1.42	0.156	-5.225653	.8401048
head_d	.4494068	1.24977	0.36	0.719	-2.000097	2.898911
mid_d	-1.951489	1.215658	-1.61	0.108	-4.334135	.4311566
age_of_dam	.6030801	.1019723	5.91	0.000	.4032181	.8029421
perception_rainadeq	-2.248748	1.047702	-2.15	0.032	-4.302207	-.1952895
_cons	2.593317	3.399829	0.76	0.446	-4.070225	9.25686

ddidu_clean						
have_mobilephone	.1580931	.3225341	0.49	0.624	-.4740621	.7902483
have_radio	-.2769498	.4009159	-0.69	0.490	-1.062731	.5088309
have_TV	-.4135086	.409598	-1.01	0.313	-1.216306	.3892888
age	.0117523	.0111943	1.05	0.294	-.0101881	.0336926
education	.0793588	.0558755	1.42	0.156	-.0301552	.1888728
laborforce	.3511934	.1315871	2.67	0.008	.0932874	.6090994
distance_awr	.0117864	.0101126	1.17	0.244	-.008034	.0316067
size_irrgation_farm	-.9385664	1.849104	-0.51	0.612	-4.562744	2.685611
size_rainfed_farm	.9626257	1.871079	0.51	0.607	-2.704623	4.629874
income_irrgation	.0007265	.0002372	3.06	0.002	.0002616	.0011914
memb_communityorg	.8435066	.381987	2.21	0.027	.0948258	1.592187
distance_inputmarket	-.0005716	.0113478	-0.05	0.960	-.0228128	.0216695
distance_sellingmarket	-.0012408	.0027076	-0.46	0.647	-.0065475	.0040659
hhsex	-.6827671	.3778268	-1.81	0.071	-1.423294	.0577599
extension_rain	.5115871	.6592185	0.78	0.438	-.7804575	1.803632
extension_irrigation	.5030406	.6522251	0.77	0.441	-.7752971	1.781378
head_d	.7273813	.3677098	1.98	0.048	.0066832	1.448079
mid_d	.6827659	.4404546	1.55	0.121	-.1805092	1.546041
age_of_dam	.0505378	.0459214	1.10	0.271	-.0394664	.140542
perception_rainadeq	.7645888	.4544168	1.68	0.092	-.1260519	1.655229
_cons	-3.00534	1.137245	-2.64	0.008	-5.234298	-.7763815
mills						
lambda	3.759433	2.00891	1.87	0.061	-.177959	7.696824
rho	0.63602					
sigma	5.9108834					

Variable	VIF	1/VIF
extension~on	3.22	0.310738
size_irrga~m	3.16	0.316088
extension~in	3.15	0.317263
age_of_dam	2.68	0.373050
size_rainf~m	2.21	0.452499
head_d	2.17	0.460445
lambda	2.01	0.498536
distance_awr	1.98	0.504193
distance_s~t	1.94	0.514155
mid_d	1.85	0.540675
education	1.68	0.594036
have_mobil~e	1.65	0.604731
perception~q	1.60	0.624476
laborforce	1.53	0.653014
income_irr~n	1.50	0.667257
age	1.44	0.696833
hhsex	1.34	0.748237
have_TV	1.30	0.769000
distance_i~t	1.23	0.810266
have_radio	1.22	0.817946
Mean VIF	1.94	

Heckman sample selection model for how much money contributed for irrigation activities

```
. heckman cont_fund_in_birr have_mobilephone have_radio have_TV age education ///
> laborforce distance_awr size_irrgation_farm size_rainfed_farm income_irrgation ///
> distance_inputmarket distance_sellingmarket hhsex extension_rain ///
> extension_irrigation head_d mid_d age_of_dam perception_rainadeq, select (Cont_fund =have_mobilephone have_radio have_TV age educatio
> laborforce distance_awr size_irrgation_farm size_rainfed_farm income_irrgation ///
> memb_communityorg distance_inputmarket distance_sellingmarket hhsex extension_rain ///
> extension_irrigation head_d mid_d age_of_dam perception_rainadeq) twostep

Heckman selection model -- two-step estimates   Number of obs      =       240
(regression model with sample selection)        Censored obs       =        35
                                                Uncensored obs     =       205

                                                Wald chi2(19)      =    364.54
                                                Prob > chi2        =    0.0000
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
cont_fund_in_birr						
have_mobilephone	-7.040193	2.876986	-2.45	0.014	-12.67898	-1.401405
have_radio	.8016917	3.363356	0.24	0.812	-5.790365	7.393749
have_TV	-5.820649	4.538732	-1.28	0.200	-14.7164	3.075102
age	-.0249297	.0994967	-0.25	0.802	-.2199397	.1700804
education	-.3898859	.4701507	-0.83	0.407	-1.311364	.5315925
laborforce	.4623886	.8359677	0.55	0.580	-1.176078	2.100855
distance_awr	.0886426	.0463931	1.91	0.056	-.0022862	.1795714
size_irrgation_farm	60.20232	17.61929	3.42	0.001	25.66914	94.73549
size_rainfed_farm	11.37236	17.58442	0.65	0.518	-23.09248	45.8372
income_irrgation	-.0001236	.00028	-0.44	0.659	-.0006723	.0004251
distance_inputmarket	-.0555915	.0886282	-0.63	0.530	-.2292996	.1181166
distance_sellingmarket	.0561572	.0235231	2.39	0.017	.0100529	.1022616
hhsex	4.948673	2.929289	1.69	0.091	-.7926271	10.68997
extension_rain	5.50774	4.266128	1.29	0.197	-2.853717	13.8692
extension_irrigation	11.10332	4.188984	2.65	0.008	2.893062	19.31358
head_d	-7.452146	3.238671	-2.30	0.021	-13.79982	-1.104469
mid_d	-9.128276	3.262249	-2.80	0.005	-15.52217	-2.734386
age_of_dam	2.135239	.2980153	7.16	0.000	1.55114	2.719338
perception_rainadeq	12.65465	2.864624	4.42	0.000	7.040085	18.26921
_cons	-16.27861	9.33328	-1.74	0.081	-34.5715	2.014286
Cont_fund						
have_mobilephone	.356923	.33408	1.07	0.285	-.2978618	1.011708
have_radio	-1.066881	.4131441	-2.58	0.010	-1.876629	-.2571336
have_TV	-1.422322	.4517482	-3.15	0.002	-2.307732	-.5369119
age	.0338079	.0128141	2.64	0.008	.0086927	.0589231
education	.1680333	.0632477	2.66	0.008	.04407	.2919966
laborforce	.2964761	.1389356	2.13	0.033	.0241673	.5687849
distance_awr	.0537004	.025272	2.12	0.034	.0041682	.1032326
size_irrgation_farm	9.779384	3.879417	2.52	0.012	2.175866	17.3829
size_rainfed_farm	-8.05382	2.135614	-3.77	0.000	-12.23955	-3.868092
income_irrgation	.0001387	.0001315	1.06	0.291	-.000119	.0003965
memb_communityorg	1.222581	.4142078	2.95	0.003	.4107489	2.034414
distance_inputmarket	-.0091496	.0080999	-1.13	0.259	-.0250251	.006726
distance_sellingmarket	-.0004391	.0029546	-0.15	0.882	-.0062299	.0053518
hhsex	.0118875	.364473	0.03	0.974	-.7024665	.7262414
extension_rain	.7080979	.6019133	1.18	0.239	-.4716304	1.887826
extension_irrigation	.093086	.6506166	0.14	0.886	-1.182099	1.368271
head_d	-.5142963	.4075686	-1.26	0.207	-1.313116	.2845234
mid_d	-.7769051	.4796743	-1.62	0.105	-1.717049	.1632392
age_of_dam	.226604	.0935672	2.42	0.015	.0432157	.4099923
perception_rainadeq	1.35911	.4872213	2.79	0.005	.4041742	2.314047
_cons	-5.80884	2.243403	-2.59	0.010	-10.20583	-1.411851
mills						
lambda	-5.776468	6.625773	-0.87	0.383	-18.76275	7.20981
rho	-0.35270					
sigma	16.377994					

Variable	VIF	1/VIF
extension~in	3.10	0.322741
extension~on	3.03	0.329660
age_of_dam	3.01	0.332727
size_irrga~m	2.51	0.399104
size_rainf~m	2.26	0.443244
lambda	2.21	0.452569
distance_awr	2.16	0.462735
distance_s~t	1.94	0.516404
head_d	1.92	0.520538
education	1.71	0.583231
mid_d	1.68	0.595407
have_mobil~e	1.58	0.633787
perception~q	1.56	0.639094
income_irr~n	1.52	0.656074
laborforce	1.49	0.671522
age	1.42	0.704085
have_TV	1.41	0.710657
hhsex	1.31	0.761381
distance_i~t	1.22	0.820025
have_radio	1.18	0.849871
Mean VIF	1.91	

Heckman sample selection model for how many meetings attended

```
. heckman meet_attended have_mobilephone have_radio have_TV age education ///
> laborforce distance_awr size_irrgation_farm size_rainfed_farm income_irrgation ///
> distance_inputmarket distance_sellingmarket hhsex head_d mid_d age_of_dam ///
> perception_rainadeq, select (dmeting_ind =have_mobilephone have_radio have_TV age education ///
> laborforce distance_awr size_irrgation_farm size_rainfed_farm income_irrgation ///
> memb_communityorg distance_inputmarket distance_sellingmarket hhsex head_d mid_d ///
> perception_rainadeq age_of_dam) twostep
note: two-step estimate of rho = -1.225045 is being truncated to -1

Heckman selection model -- two-step estimates   Number of obs      =       239
(regression model with sample selection)        Censored obs      =        25
                                                Uncensored obs    =       214

                                                Wald chi2(17)     =    114.16
                                                Prob > chi2       =    0.0000
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
meet_attended						
have_mobilephone	-.8894139	.5474299	-1.62	0.104	-1.962357	.1835291
have_radio	-.852685	.6214332	-1.37	0.170	-2.070672	.3653017
have_TV	-.3260779	.8279213	-0.39	0.694	-1.948774	1.296618
age	.0077842	.0189795	0.41	0.682	-.0294149	.0449834
education	.1179998	.0876036	1.35	0.178	-.0537002	.2896998
laborforce	.1117922	.1755006	0.64	0.524	-.2321828	.4557671
distance_awr	.0064682	.0096747	0.67	0.504	-.0124938	.0254302
size_irrgation_farm	11.9711	4.003565	2.99	0.003	4.124256	19.81794
size_rainfed_farm	-5.271587	3.253133	-1.62	0.105	-11.64761	1.104437
income_irrgation	.0000153	.0000569	0.27	0.788	-.0000963	.0001269
distance_inputmarket	.0306758	.0154223	1.99	0.047	.0004487	.0609029
distance_sellingmarket	.0104477	.0046594	2.24	0.025	.0013154	.01958
hhsex	.6630517	.5677403	1.17	0.243	-.4496989	1.775802
head_d	-.7011374	.6101298	-1.15	0.250	-1.89697	.4946951
mid_d	1.345744	.6114175	2.20	0.028	.1473878	2.544101
age_of_dam	.2293629	.0644235	3.56	0.000	.1030953	.3556306
perception_rainadeq	.4141074	.544594	0.76	0.447	-.6532772	1.481492
_cons	1.974677	1.930123	1.02	0.306	-1.808295	5.757649
dmeting_ind						
have_mobilephone	.246121	.3061449	0.80	0.421	-.353912	.8461539
have_radio	-.0572232	.4589191	-0.12	0.901	-.9566881	.8422416
have_TV	-.9362437	.4311629	-2.17	0.030	-1.781308	-.09118
age	.0034185	.0108434	0.32	0.753	-.0178342	.0246712
education	.0030434	.054617	0.06	0.956	-.104004	.1100908
laborforce	.3584933	.1288862	2.78	0.005	.105881	.6111057
distance_awr	.0171104	.0107597	1.59	0.112	-.0039781	.038199
size_irrgation_farm	-.0125205	1.719566	-0.01	0.994	-3.382807	3.357766
size_rainfed_farm	1.522477	1.888198	0.81	0.420	-2.178322	5.223277
income_irrgation	.0002517	.000156	1.61	0.107	-.0000541	.0005575
memb_communityorg	.6717032	.3945828	1.70	0.089	-.1016649	1.445071
distance_inputmarket	.0031345	.0140605	0.22	0.824	-.0244236	.0306926
distance_sellingmarket	-.0025408	.0024487	-1.04	0.299	-.0073402	.0022585
hhsex	-.3783686	.3405661	-1.11	0.267	-1.045866	.2891287
head_d	-.164324	.4077589	-0.40	0.687	-.9635167	.6348686
mid_d	-.0063438	.4565894	-0.01	0.989	-.9012427	.8885551
perception_rainadeq	.3779425	.4231039	0.89	0.372	-.451326	1.207211
age_of_dam	.1257236	.0478061	2.63	0.009	.0320254	.2194218
_cons	-2.026471	1.177253	-1.72	0.085	-4.333845	.2809034
mills						
lambda	-3.282997	1.6991	-1.93	0.053	-6.613172	.0471771
rho	-1.00000					
sigma	3.2829974					

Variable	VIF	1/VIF
age_of_dam	3.67	0.272472
size_irrga~m	3.01	0.332142
lambda	2.76	0.362464
distance_awr	2.47	0.405366
size_rainf~m	2.28	0.438648
distance_s~t	2.06	0.485324
head_d	1.85	0.540378
laborforce	1.72	0.580365
mid_d	1.61	0.620758
have_mobil~e	1.60	0.625494
education	1.60	0.626362
income_irr~n	1.55	0.643852
perception~q	1.51	0.661720
age	1.43	0.697629
have_TV	1.41	0.708909
hhsex	1.40	0.713436
distance_i~t	1.20	0.830756
have_radio	1.17	0.855684
Mean VIF	1.91	

Household level questionnaire for the survey

Name of household head_____ Code_____

Keble/Tabia_____ Code_____

Woreda _____ Code_____

Zone_____Code_____

1. Current Household Characteristics (a "household" includes all members that live in the household**)**

Sex of household head	Marital status (use Code) 1.1	Age of household head in years 1.2	Highest grade of school completed by household head 1.3	No of household members between the ages of 15-64 1.4	Size of family(Total number of person) 1.5	Occupation of household head (use Code)	
						Primary 1.6	Secondary 1.7

Codes for Table 1

Marital Status
1=Single 2=Married 3=Divorced 4=Widowed/ Widower

Occupation
1 = Crop farming 2 = Livestock & poultry keeping (incl. sales) 3 = Unpaid domestic help 4 = Trading in livestock and livestock products (not own)
5 = Trading in agricultural Products (excluding livestock!) (Not own produce) 6 = Salaried employee (e.g. civil servant, domestic work)
7 = Business – trade / services (non-agric.) 8 = Not working / unemployed 9 =Old/Retired 10 = Infant (<6 years) 11 = Student/ pupil
12 = other (specify)

2. Household Asset

Asset	Did your household own the Asset in the production season? (1=yes 2=no) 2.1	Number owned with their values:								
		Total 2.2	Value 2.3	Head 2.4	Value 2.5	Spouse 2.6	Value 2.7	Jointly 2.8	Other Members 2.9	Value 2.10
Mobile Phone										
Motorized Pump										
Treadle Pump										
Water Can										
Agricultural tool (sickle)										
Agricultural tool (Hoe)										

Agricultural tool spade (both iron and wood										
Agricultural tool (Fork)										
Radio										
Television										
Other (specify)										

3. Farm Cultivation.

3.1 Did you cultivate your farm in 2007 E.C? (Yes/no) Yes Code _____

3.2 Do you have an irrigated farm? (Yes/no)Yes Code _____

3.3 Do you have a rained farm? (Yes/no) Yes Code _____

3.4 If yes to question 2 what is the distance of plot number 1 from homestead in walking minutes?

3.5 Do you spend more time farming on the irrigation farm or the rain fed farm?

3.6 Do you have access to all-weather road? (Yes/no) Yes Code _____How many minutes does it take you to reach the all-weather road?

If **Yes Question 2** complete the following table for household who has an irrigated agricultural land.

Plot name/ Parcel name 3.6	Crop produced 3.7	Type of irrigation 3.8	Size of the irrigation farm/ Plot size (Timad or Kert) 3.9 1 Timad	If rented in, how much paid? (Birr) 3.10	If rented out, how much received? (Birr) 3.11	Shared in (%) of production paid) 3.12	Shared out (%) of production received 3.13	Total Production in (Kg) 3.14	Position of block (head, mid ,tail) 3.15	Code

If **Yes to Question 3** complete the following table for household who has rain fed agricultural land.

Plot name / Parcel name 3.16	Crop Produced 3.17	Size of the rain fed farm/ Plot size (Timad or Kert) 3.18	If rented in, how much paid? (Birr) 3.18	If rented out, how much received? (Birr) 3.19	Shared in (%) of production paid) 3.20	Shared out (%) of production received 3.21	Total Production in (Kg) 3.22

4. Livestock ownership

4.1 Do you own any livestock? (Yes/no)_____ Code_____

4.2 Do you own small ruminants (sheep, goat)? (Yes/no)_____ Code_____if yes how many

4.3 Do you own Cattle (Cows, Oxen)? (Yes/no) 3 Code_____ if yes how many

4.4 Distance to Livestock market in walking minutes?

5. Access to market

Fill in the following table for your market access and participation

Commodity Sold 5.1	Quantity Sold in Kg 5.2	Average price birr/ Kg 5.3	Total value sold (birr) 5.4	Distance to input market walking time(minutes) 5.5	Distance to crop selling market walking time(minutes) 5.6	Market Places (% sold at each place) Use code						Type of buyer (outlet) (% sold at each place) Use code						
						FG 5.7	MP 5.8	MOP 5.9	DM 5.10	MZ 5.11	RM 5.12	FR 5.13	AS 5.14	WS 5.15	RT 5.16	PR 5.17	UC 5.18	CP 5.19

Market places: FG=Farm-gate; MP= Market in (tabia); MOP= Market in other PA(tabia); DM= market at District capital; MZ= Market at zonal capital; RM= Market at Regional capital

Type of buyers: FR=Farmer; AS=Assembler; WS=Wholesaler; RT=Retailer; PR=Processor; UC=Urban consumer; CP=Cooperative

6. Participation in agricultural extension and training programs for rainfed plot

Did any of household members participate in any agricultural extension training programs in 2007 E.C for rainfed farm? (Yes/no)_____ Code _____

If **Yes** complete the following table for any household member who participated in any agricultural extension training programs (including BOA, REST, other NGO programs) in 2007 E.C.

Name of household member	Program/organization 6.1	Code 6.2	Areas of training 6.3	Code 6.4

7. Participation in agricultural extension and training programs for irrigated plot

Did any of household members participate in any agricultural extension training programs in 2007 E.C for irrigated plot? (Yes/no)_____ Code _____

If **Yes** complete the following table for any household member who has participated in any agricultural extension training programs (including BOA, REST, other NGO programs) in 2007 E.C.

Name of household member	Program/organization 7.1	Code 7.2	Areas of training 7.3	Code 7.4

8. Membership in organizations

Did any of household members belong to any local or external organizations or committees in 2007 E.C? (Yes/no)_____ Code _____

If yes complete the following table for any household members who have belonged to any local or external organizations or committees. (Including tabia baito, kushet baito, men's association, women's association, youth association, elders association, agricultural cadre, church association, water users group, edir group, input supply cooperative, marketing cooperative, savings (equb) group, etc.)

Organization CBOs	Code 8.1	Main functions of the organization/roles of organization 8.2	Code 8.3	Local org.? (org. within tabia) 8.4	Amount of years since established 8.5	Year became member 8.6	Year stopped being member (if appl) 8.7

Codes for 8.1

1=tabia 2=Kushet 3= men's association 4= women's association 5= youth association 6= elders association
7= agricultural cadre cooperative 8=church association 9= water users group 10 = edir group 11=input supply cooperative 12=marketing 13= savings (equb) group

9. Credit access (cash or kind) – formal sources (banks, cooperatives, BOA, REST, other programs) and **informal sources** (moneylenders, traders, intermediaries, friends, relatives, others)

Credit Access

9.1 Did your household need credit during the 2007 production season?	1=yes 2=no	Code:	if no stop here
9.2 If yes, did you apply for credit	1=yes 2=no	Code:	If no stop here
9.3 If yes, did you receive credit	1=yes 2=no	Code	If yes fill in Table below
9.4 If you didn't, why not			
9.5 Did you receive the loan from formal or informal source	1= Formal 2= informal		

Purpose credit was received for (use code) 9.6	Purpose credit was actually used for(use code) 9.7	Amount of credit (birr) 9.8	Source of credit (use code 9.9	Distance to source of credit in Walking minutes 9.10	Terms of credit (months) 9.11	Loan type (1=group 2= individual) 9.12	Annual interest rate (%) 9.13	Who received the credit (use code) 9.14	Level of satisfaction (use code) 9.15
				20					

Purpose of credit (9.6 & 9.7): 1= input purchase for field crop production 2= input purchase for vegetable production 3= input purchase for fruit production 4= input purchase for dairy 5= input purchase for cattle fattening 6= input purchase for small ruminant production 7= input purchase for small ruminant fattening 8= input purchase for apiculture 9= input purchase for poultry 10=input purchase for fodder 11= to buy irrigation equipment 12= to buy food 13= for medication 14= for schooling 15= for trading 16=other (specify)
Source of credit (9.9): [1] Banks [2] Friends / relatives / neighbors [3] Buying traders [4] Microfinance [5] Other (specify) 6= Cooperatives 7=NGO (specify) 8= Government office (e.g. agriculture office)
Who received credit (Code 9.14): 1 = Head only 2 = Spouse only 3 = Head and spouse 4= Male children only 5 = Female children only 6= Male and female children 7= all household members 8=others (specify) 9=head and male child only 10=Spouse and female child only;
Level of satisfaction (Code 9.15): 1] Very Poor [2] Poor [3] Good [4] Very Good

10. Income and Saving

10.1 Did you earn income in the 2007 E.C production season?	1=yes 2=no	Code	If yes how much
10.2 Did you Consume all of your income earned in 2007 E.C?	1=yes 2=no	Code	If yes how much
10.3 How much income did you earn from irrigation farm (farms)?			
10.4 Did you save certain portion of your income in 2007 E.C?	1=yes 2=no	Code	If no stop here if yes how much
10.5 Do you have a bank account?	1=yes 2=no	Code	If yes how much did you save in 2007 E.C
10.6 How much do you have saved in your bank account?			

11. Participation variables

12.1, was there any canal/wells cleaning done in 2007 E.C? (Yes/no) _____ Code_____ if no go to 12.5

12.2, in which scheme did the cleaning took place?

12.3, did you contribute your labor for canal/wells cleaning in 2007 E.C? (Yes/no) _____ Code_____

12.4, how many person day?

12.5, was there any canal/wells repairs done in 2007 E.C? (Yes/no) _____ Code_____ if no go to 12.8

12.6, did you contribute your labor for canal/wells repairs in 2007 E.C? (Yes/no) _____ Code_____

12.7, how many person day?

12.8, was there any contribution of funds for scheme management in 2007 E.C? (Yes/no) _____Code_____ if no go to 12.11

12.9, did you contribute funds for scheme management in 2007 E.C? (Yes/no) _____

12.10, if yes, how much money did you contribute?

12.11, did you contribute funds towards water user associations in 2007 E.C? (Yes/no) _____ if no go to 12.13

12.12, if yes, how much money did you contribute monthly?

12.13, is there a meeting that is held by the water users association to discuss on issues about water? (Yes/no) _____ Code _____

12.14, is this meeting based on a certain group of members or all the members individually? (Yes/no) _____Code_____

12.15, if yes in how many of them do you participate?

12.16, how many meetings are held per month?

12.17, was there any unlawful use of water in 2007 E.C? (Yes/no) _____Code _____

12.18, did you observe the unlawful use of water? (Yes/no) _____ Code _____ if no go to the separate questions

12.19, did you report any unlawful use if water in 2007 E.C? (Yes/no) _____Code _____

12.20, how many times did you report unlawful use of water in 2007 E.C? (Yes/no) Code _____

13. Separate Questions

-
- Do you think the amount of rainfall is adequate for the farm? (Yes/no) _____ Code _____
- Are you a part of an irrigation association in your irrigation farm area? (Yes/no) _____ Code _____ if yes how much irrigators are there in that group? _____
- Where you there during the construction of irrigation scheme? (Yes/no) _____ Code _____

- If yes what was the year?
- Did you come across water availability problems for irrigating your farm relating to excess water when not needed in 2007 E.C? (Yes/no) _____ Code _____ Why was it_____
- Did you come across water availability problems for irrigating your farm relating to less water than required in 2007 E.C? (Yes/no) _____ Code _____ Why was it _____ Who resolved the conflict and how _____
- Did you come across water availability problems for irrigating your farm relating to mismatch between timing of water allocation in 2007 E.C? (Yes/no) _____ Code _____ Why was it_____ Who resolved the conflict and how _____
- Did you come across water availability problems for irrigating your farm relating to in a Water related conflict in 2007 E.C? (Yes/no) _____ Code _____ Why was it Water Security Problem Who resolved the conflict and how _____
- Do you think the water distribution to your plot was adequate in 2007 E.C? (Yes/no) _____ Code _____
- Do you think the water distributed to your plot is fair in 2007 E.C? (Yes/no) _____Code _____
- Do you have extension contact in livestock? (Yes/no) _____
- Have you ever obtained training from farmer training centers (Yes/no) _____ if yes how many minutes is the distance to the farmer training center?